

E 12

THE GRAMMAR OF SOUTH INDIAN (Karnatic) MUSIC

BY

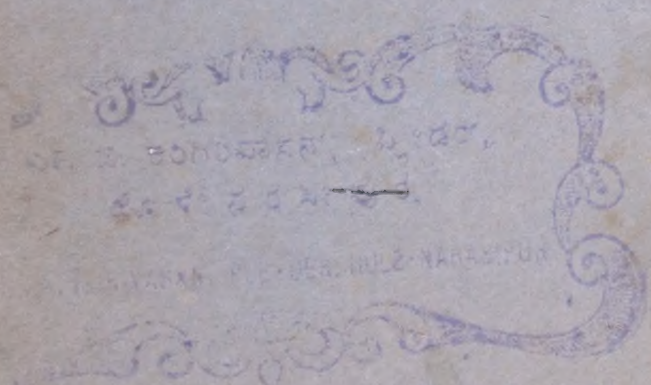
C. SUBRAHMANYA AYYAR, B.A.

Retired, Accountant-General and Member of the Board of Studies,
Indian Music, University of Madras

'MUSIC IS A RATIONALISATION OF SOUND AND
A MATHEMATICS BECOME AUDIBLE'

GEORGE SANTAYANA,

'Reason in Art'



1951]
37

[Price : Rs. 2-8-0

28/2/52

N. G. K.

THE GRAMMAR
OF
SOUTH INDIAN (Karnatic) MUSIC

BY

C. SUBRAHMANYA AYYAR, B.A.,

Retired Accountant-General and Member of the Board of Studies,
Indian Music, University of Madras

'MUSIC IS A RATIONALISATION OF SOUND AND
A MATHEMATICS BECOME AUDIBLE'

GEORGE SANTAYANA,

'Reason in Art'

First Edition 1939.

Second Edition with additions 1951.

All Rights Reserved.

PRINTED AT ANANDA PRESS, MADRAS
AND PUBLISHED BY THE AUTHOR
46, EDWARD ELLIOT ROAD, MYLAPORE, MADRAS 4.

CONTENTS.

	Page
Preface to 1st Edition	1
Do. to 2nd Edition	2
Preliminary Note	3
Chapter I. Western Interpreters and Our Music	7
Annexe to Chapter I	35
Chapter II. Gamakas and Śrutis	35
Chapter III. Māyā Mālava Gauḷa Rāga	48
Chapter IV. Certain five note (Oudava) Rāgas	52
Chapter V. General Considerations	55
Chapter VI. Replies to Questions in Chapter I	64
Chapter VII. Proposed Theory of Karnātic Music	68
Chapter VIII. Six Major Rāgas	79
Chapter IX. Rāgas Kanakāṅgi and Chala Nāta	86
Chapter X. Rhythm or Tala	89
Chapter XI. Rāga Mela Scheme	100
Chapter XII. Janya rāgas	104
Chapter XIII. Observations	117
Chapter XIV. Rāga, Rasa (Emotion) and Aesthetics	125
Chapter XV. Musical metaphor—what the violin has taught me	132
Epilogue in the 1st Edition	136
Finale	142
Appendix, a study of vibration curves	1 to 8
Plates 1, 2, 3 and 4.	

Addenda in 2nd Edition.

Vide pp. 2, 6, 31, 35 (annexe), 43, 49, 71, 75, 100, 114 to 116, 118, 119, 124, 125, the finale chapter and an appendix (8 pages) with one plate.

EXTRACT FROM THE REVIEW OF THE
FIRST EDITION
IN
'MUSIC & LETTERS', LONDON

January, 1940.

The structure of the scale, European or Indian, is not a subject that can be made very entertaining. Mr. Ayyar is at any rate clear, * * * * *

The European, wedded for sufficient reason to equal temperament, has not forgotten that he had, three centuries ago, pure intonation, and he can therefore understand the Indian scale, though he may be unable to feel it.

Both scales fill an octave with twelve semitones of different sizes and both therefore have a comma (the quotient of the major and minor tones) to negotiate. The crux is in the first three notes—in the C-scale, D \flat , D \square , E \flat .

	C	D \flat	D \square	E \flat	See page 28 last para, C.S.
Europe...	o	<i>112</i>	<i>204</i>	<i>316</i>	
India ... {	o	<i>112</i>	<i>182</i>	<i>294</i>	C-string
	o	<i>92</i>	<i>204</i>	<i>316</i>	G-string

The numbers italicized show our intervals 16/15, 9/8, 6/5, and are correct, and they recur on one or other of the Indian strings. But of the *consonances these make* three of ours are false—B \flat -D, D-A, E \flat -B \flat ; while on the Indian C-string B-D, D-F \sharp , G-D, E \flat -G, and on the G-string B \flat -D, D \flat -F, D \flat -A \flat , D-A, E \flat -B \flat are false. Thus on one or other string, but not on both, the Indian can get all his consonances true, whereas on our keyboard there are three that are always false; our strings create no problem, of course, because they are not fretted. * * * *

A. H. FOX STRANGWAYS.

EXTRACT FROM THE FOREWORD TO THE FIRST EDITION.

In these days of revival of general interest in South Indian music, the fundamental principles of Karnatic music are more and more widely studied and discussed. The modern mind is not satisfied with the traditional method of exposition of the intricacies of music. A more rational and scientific approach to the subject is increasingly in demand. The author of this book has been confronted with this problem for many years, and has made a systematic and scientific study of one of the most important aspects of Indian Music, namely the origin and interpretation of the twenty-two srutis. He has made a thorough study of the subject by using a long sonometer and standard tuning forks. He has tried *objectively* to understand the subtleties of South Indian Ragas, the Raga Bhavas and Gamakas. He published a series of articles in "The Hindu" in 1928 and the matter was then widely discussed.

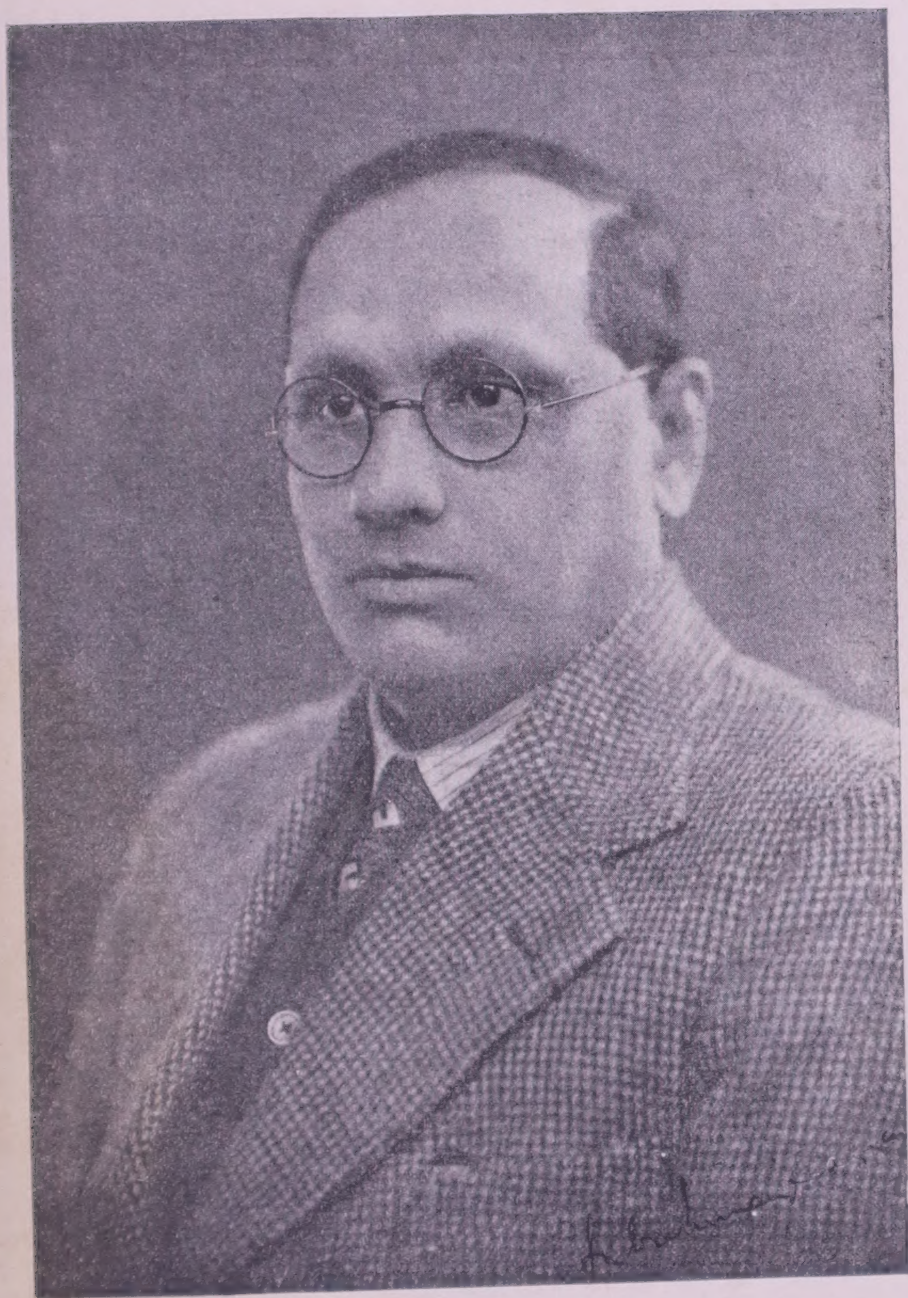
The conclusions arrived at as a result of a critical study and observation extending over a period of twelve years, have been embodied in this book—The grammar of South Indian (Karnatic) Music. * * * * *

The thesis thus attempted by the author is of deep interest though radical, being quite contrary to the traditional interpretation of the old texts on music, which are not always unanimous. Anyway, such a disturbing proposition must set all thinking artists to a great deal of activity and before long, I hope its truth will be established beyond doubt.

V. APPA RAO,

9—8—1939

*Retired Professor of Physics,
Presidency College, Madras.*



PHOTO]

THE AUTHOR [WYKEHAM, LONDON.



1. The Thambura
2. A Lady playing on the Vina



3. A vertical view of the Vina

PREFACE TO THE FIRST EDITION.

My reason in bringing out this book is that I have been harping on the subject of *Śrutis* or microtones since the year 1928, and lecturing to interested audiences* in Madras, Calcutta, Bombay and Allahabad. I feel the paramount necessity for the correct perception of microtones by all artists, vocalists and instrumentalists alike, for their clear exposition of the Rāga *Bhāva*. I place this book before all learners to popularise the idea of *Śrutis* so that these mathematical conceptions may help them and lead *as in my case* to a better exhibition of the art itself. The book will certainly be of use to students of music, who have gained sufficient understanding to be able to decipher any melodic music by the twelve rough pitches in the octave or *Sthāyi*. It may also interest the general reader, who may perhaps find in this book, a statement of the evolution of our music from simpler melodic pieces to the present art-étage.

The present thesis purposely does *not* refer to the more ancient theoretical works on music in Sanskrit. It is based entirely on my musical experience with a little knowledge of modern Physics, and of musical comparisons and unisons suggested by a musical ear. I have also added two Chapters of general musical interest.

*(i) Journal of the Music Academy, Madras, Vol. II, 1931.

(ii) Lecture on Music and Numbers on 17-1-1933 reproduced in the Calcutta Review for May 1933.

(ia) Proceedings, Allahabad University Conference of the year 1934.

PREFACE TO THE SECOND EDITION.

Since the publication of the first edition, I have perused the translation of the many ancient and recent Sanskrit texts on the subject of *Śrutis*. The several interpretations put upon them by the Sanskritists *cum* musical Theorists in the matter of evaluating their relative frequencies with reference to the fundamental, in the language of the Physicist, leave the reader bewildered. Mr. Bhātkande's book 'A comparative study of some of the leading music systems of the 15th, 16th, 17th and 18th centuries' which is a concise summary of all texts, leaves no one very much the wiser for all the pains the author has taken.

Far better it is to study *objectively* the living art-music of South India and its foremost living, stringed instrument, the Vīna, by methods known to modern physics, so as to realise the science and laws of the melodic art. The results of the study by a physicist, of the plates of violin curves taken by the Duddell Oscillograph, (mentioned in the epilogue) of my violin play of certain *Gamakas*, have now been incorporated herein, as an appendix, with a photo-block to illustrate the same. This appeared as a *scientific* paper in the 'Current Science' of Bangalore, India, for August 1949, and is listed at page 525 of the Journal of the Acoustical Society of America, Volume No. 22, No. 4 of July, 1950.

The book has, to a certain extent, been revised.

C. S.

PRELIMINARY NOTE.

The book is intended to be read throughout India by both Hindustāni and South Indian artistes, and by Europeans, who have evinced interest in Indian music, both Hindustāni and Karnātic. Hence, complexity of description is unavoidable. The following notation and symbols will be used in transcribing the music, *i.e.*, when the ascending (Ārōha) and descending (Avarōha) notes (Svaras) are given for any rāga, melody form.

Notes. The signs,

C d D e E F f G a A b B C̣ will be used, the capitals for the *white* keys of a Piano and the *small* letters for the *black* keys, i.e., flats in the case of D E A and B, and sharp in the case of F, for the twelve frets in the octave (Sthāyi) to be represented in Indian notation by the signs,

<i>Svaras</i> of	Sa	ri	Ri	ga	Ga	Ma	ma	Pa	da	Da	ni	Ni	Śa
the middle			or		or					or		or	
octave.			(ga)		(Ri)						(ni)		(Da)

The symbols in brackets will be explained later.

It is presumed that the fundamental pitch, which the singer adopts, will be represented by C, or Sa in the notation, though it may not be intrinsically C of 256 vibrations per second. Notes of the higher octave will have a dot above, and the notes of the lower octave a dot below

them. The prolongation of the time of the notes will be represented by commas (, , ,) one, two, or three as the case may be, to represent the prolongation by one or more measures, of the note subsequent to which it is put. A semi-colon (;) is occasionally used to represent two commas of length of time.

The music will be written by the several time measures consisting of say 8, 7, 6, or 5 units as the case may be, and to denote the time measures, the numbers 1, 2, 3, 4, 5, 6, 7, 8 will be written above the 'Sarigama' notation, each phrase being separated by vertical lines thus ||. A single dash (—) above the 'Sarigama' notation will represent that the notes will run in half time, and two dashes (=) will denote that they will run in a quarter of the unit time. There is no need for further elaboration, as melodies generally run from (lower) $\dot{M}a$ or $\dot{P}a$, and pass through a middle octave to (higher) $\ddot{P}a$. Thus $\dot{S}a, \overline{\dot{K}i} \overline{\dot{S}a}$ $\dot{S}a$ will represent 4 units of time.

N.B.—I have purposely used Da or da to represent 'Dhaivata'. The South Indian has long since practically dropped the sound 'Dha' in svara singing and substituted for it the unaspirated Da, excepting on a few occasions in rāgas Sankarābharana or Kalyāni and only very rarely in Kāmbodi. In all other rāgas, the sound 'Da' is used generally, including the flat variety, which I have denoted by the small 'da'.

Note.—The corresponding names of South Indian, (Karnātic) and “Hindustāni” notes in *common parlance* are given below :

Karnātic.	Sign.	Hindustāni.
Svaras or Notes.		Follows Bilāwal scale or the Diatonic scale for Suddha notes.
1. Shadja.	Sa	Shadja.
2. Suddha rishabha.	ri	Komal rishabha.
3. Chatusruti Rishabha or Suddha gāndhāra.	Ri } (ga) }	Suddha Rishabha.
4. Sādhārana gāndhāra or Shadśruti Rishabha.	ga } (Ri) }	Komal gāndhāra.
5. Antara Gāndhāra.	Ga*	Suddha Gāndhāra.
6. Suddha Madhyama.	Ma	Suddha Madhyama.
7. Prati madhyama.	ma	Tivra madhyama.
8. Pañchama.	Pa	Pañchama.
9. Suddha dhaivata.	da	Komal dhaivata.
10. Chatusruti Dhaivata or Suddha nishāda.	Da } (ni) }	Suddha Dhaivata.
11. Kaisiki nishāda. or Shadśruti Dhaivata.	ni } (Da) }	Komal nishāda.
12. Kākali Nishāda.	Ni	Suddha Nishāda.
13. Tāra Shadja.	Śa	Tāra Shadja.

* I prefer to call this svara *Antargata* Gāndhāra (meaning that which merges with Sa and Pa.) This note of frequency $5/4$ is also heard when the four strings of the Tambura are struck. Its strings are tuned thus, (Lower)

Ṣa, Sa, Sa, (Lower) Pa, with frequencies $1/2$, 1, 1, $3/4$ counting from the position next to the singer. See Plate 1, and thus $5/4$ being the sum of the frequencies of the first and the last strings ($\frac{1}{2} + \frac{3}{4}$) is heard under the principle of summation tones. The strings are, however, twanged Pa Sa Sa Ṣa *i.e.*, in the reverse order.

Occasionally the Tambura is also tuned as (lower) Ṣa, Sa Sa and (lower) Ma. This is called Madhyama Śruti. The frequencies then are $1/2$, 1, 1, $2/3$. What was originally Sa of the singer becomes Pa, as it were, of the music. The relative frequencies are thus $3/4$, $3/2$, $3/2$, 1. Note also the *jeevādhāra*,* the silk string underneath the wires and over the bridge to make the tone resonant, when the point of contact of the string with the bridge is properly adjusted. See Plate 1.

Note added in Second Edition.

**Re* the acoustical effect of the 'jeevādhāra' of the tambura and of the *curved* bridge of the Vina, the reader is referred to the paper on 'Some Indian Musical instruments' by Sir C. V. Raman F. R. S., N. L. in Vol. VII (1921-22) of the Pros. Indian Assn. for the Cultivation of Science, Calcutta. These instruments give out powerful overtones, or partials having a node at the plucked point.

CHAPTER I.

WESTERN INTERPRETERS AND OUR MUSIC.

It will be clear to any one, even to a beginner, who starts from the 'Gītams,' that if one just plays the 'svaras' (notes) given against the *Sāhitya* or the words of the melody, there is only just an attempt at reproducing the melody; and the melody does not sufficiently resemble what the voice produces. Even a beginner, practising on an instrument (the Vīna or the violin), learns before even the first few lessons are over, an idea of *Svara-sthānas* (and their purpose) in the octave obtaining on the frets of the Vīna, or the twelve *positions* of the fingers on the Violin.

For an understanding of the subject, it is necessary that certain fundamental physical facts should be appreciated. The science of Physics tells us that certain definite recognized pitches are heard at certain aliquot parts of strings. Even from the time of Plato, it was known that the sounds, which emerged at divisions of the strings in simple aliquot parts, were certain definite musical notes, and from these facts Physicists have obtained the relative frequency ratios. For example, it may be stated that if the frequency of a whole vibrating string is 1, the relative frequencies of the smaller portions of the string will be in the *inverse* ratio of the *vibrating lengths* of the string, provided the tension is constant.

The following table will show what relative frequencies are obtained from what aliquot parts of each string.

TABLE I.

Name of string.	Portion damped from one end.	Length of the vibrating string.	Rel. frequency.	Name of Note	English name.
1	2	3	4	5	6
Sa	nil	Whole	1	Shadja	Tonic.
„	1/2	1/2	2	Higher Sa	The octave.
„	1/3	2/3	3/2	Pañchama	True fifth.
„	1/4	3/4	4/3	Suddha Madhyama	True fourth.
„	1/5	4/5	5/4	<i>Antargata</i> Gāndhāra	Major third.
„	1/6	5/6	6/5	Sādhārāṇa gāndhāra.	Minor third.
„	2/5	3/5	5/3	<i>Trīśruti</i> Dhaivata though known generally as chatuśruti Dhaivata.	Major Sixth.

Of course, the tension of the string is presumed to be constant. In actual play, conditions differ, and we produce notes by pressing up to the finger board on the violin and the exact lengths may not be the same.

It may interest the reader to know that the first few frets which are placed on the Sa string of the Vina [i.e.,

the string closest to the artist, or the fundamental, i.e. the commencement of the middle octave for the human voice] are really those which produce the higher Sa, Pañchama, Sudha Madhyama, Antargata Gāndhāra and the Trīśruti Dhaivata.

The Vina of South India (*vide* Plate 3) has seven strings, four for playing the music, two of brass and two of steel. It has also three strings below for twanging with the little finger for the purposes of the drone and for rhythm. The frets are placed underneath the playing strings.

TABLE II.

Name of string.	Portion damped from head.	Length of the string vibrating.	Rel. frequency.	Name of Note.
1	2	3	4	5
Pa	Nil	Whole	$3/2$	Pañchama (Dominant.)
„	$1/2$	$1/2$	3	Higher Pañchama.
„	$2/3$	$1/3$	$9/4$	Chatuśruti Rishabha, Ri.
„	$1/4$	$3/4$	2	Higher Shadja.
„	$1/5$	$4/5$	$15/8$	Kākali Nishādha, Ni.
„	$1/6$	$5/6$	$9/5$	Kaisiki nishādha (harmonic on Pa string).
„	$2/5$	$3/5$	$5/2$	<i>Antargata</i> Gāndhāra.

It will be seen that the ratios in column 4 of Table II are $3/2$ times those in the same column of Table I.

Really on the Vina, the 2nd string behind is lower Pa, and therefore, the frequencies will be just one half of those mentioned in the examples, i.e., of the lower octave. They will be really true of the strings of the Violin, tuned Sa and Pa.

It will also be seen that the very same frets which are first placed on the Sa string of the Vina, will give the corresponding positions of the notes obtained on the Pa string.

Now let me introduce to the reader the idea of the English diatonic Major scale. It is really the Sankarābharana positions on the Sa and Pa strings. The seven notes are obtained by the Sa, Ga and Pa relationship 1, $5/4$, $3/2$, from Sa, Ma and Pa, having frequency values 1, $4/3$, $3/2$. Only Ri has to be taken down to the lower octave. Physicists have fixed the relative frequencies of Sa Ri Ga Ma Pa Da Ni Śa at the relative values of 24, 27, 30, 32, 36, 40, 45, 48 or in relative frequency ratios 1, $9/8$, $5/4$, $4/3$, $3/2$, $5/3$, $15/8$, and 2. These have already been obtained at certain aliquot parts of the strings stated above. If we just turn our attention to the Harmonium or the Piano, and take only the white keys, we have seven keys in the octave. If I play only on the white keys taking the first C as the fundamental, (or Ādhāra Śruti) I get only Sankarābharana; but if I change the fundamental, and keep on resounding the second key, for instance, to get the effect of the drone on the ear, and play on the white keys only, a different rāga effect is produced

on the ear; similarly, if I keep the fundamental as the third white key, or the fourth white key, and so on, we get different melody types. Thus it has long been recognized from ancient times that seven melodic types are produced, and these can be mathematically evaluated as below.

See Figure 1. Which gives the Sankarābharana.

MELODIC MUSIC AND NUMBERS.

Fig. 1.

Here C (Sa) is fundamental. Diatonic Major Scale:—
Sankarābharana. Melakarta 29.

	C	D	E	F	G	A	B	Ċ
	24,	27,	30,	32,	36,	40,	45,	48
Relative								
frequencies ...	1,	9/8,	5/4,	4/3,	3/2,	5/3,	15/8,	2
Intervals between <i>Svaras</i> .	9/8	10/9	16/15	9/8	10/9	9/8	16/15	

NOTES OF HIGHER OCTAVE.

	Ċ	Ḋ	Ė	Ḟ	Ġ	Ȧ	Ḃ	C̈
	48,	54,	60,	64,	72,	80,	90,	96
Intervals.	{				Major tone	9/8		
	{				Minor tone	10/9		
	{				Semi tone	16/15		
	{				Small semi tone	25/24		

I introduce here three names, the major tone, the minor tone, and the semi tone, which have relative frequencies 9/8, 10/9, 16/15. There is mention of another interval, the small semi tone, which has a

frequency $25/24$, though it is not at present relevant to the Sankarābharana scale. If the D or Ri is set as the fundamental, I get roughly the Kharaharapriya, Fig. 2. If the E or the Antargata Gāndhāra is set as the fundamental, I get roughly Hanumathodi, *see* Fig. 3. If F or Ma is set as the fundamental, I get nearly the Kālyani, *see* Fig. 4. If G or Pa is set as the fundamental, I get the Harikāmbodi, *see* Fig. 5. If A or Triśruti Dhaivata is set as the fundamental, I get Nata Bhairavi, *see* Fig. 6. These are the six Grecian scales. If B or Kākali Nishāda is set as the fundamental, I get practically Hanumathodi, except for the fifth, *see* Fig. 7. This also accords with the oral tradition that there were originally seven rāgas and that one of them was discarded.

Fig. 2.

Here D or Ri is fundamental. Kharaharapriya;
(Melakarta 22) Dorian* Mode.

	D	E	F	G	A	B	C	D
	27,	30,	32,	36,	40,	45,	48,	54
Relative								
frequency...	1,	$10/9$,	$32/27^*$,	$4/3$,	$40/27†$,	$5/3$,	$16/9$,	2
Intervals ...	$10/9$	$16/15$	$9/8$	$10/9$	$9/8$	$16/15$	$9/8$	

* Does the voice produce the note of frequency $32/27$ directly and prolong it straight?

† Here out of tune from true fifth $3/2$.

We have to raise the fifth note slightly, to $3/2$, in which case the fourth interval would become $9/8$ and the fifth interval $10/9$.

* The names of the Grecian scales have been taken from Popley's "Music of India", probably ecclesiastical names; they differ from those given in Helmholtz.

Fig. 3.

Here E or Ga is the fundamental. May possibly be, Hanumathodi (Melakarta 8). Bhairavi in Hindustāni. Black note scale. (Pārygian).

	E	F	G	A	B	C	D	E
	30,	32,	36,	40,	45,	48,	54,	60
Relative frequency	1,	16/15,	6/5,	4/3,	3/2,	8/5,	9/5,	2
Intervals	16/15	9/8	10/9	9/8	16/15	9/8	10/9	

Fig. 4.

Here F or Ma is the fundamental. Kalyāni (Melakarta 65). Lydian authentic mode.

	F	G	A	B	C	D	E	F
	32,	36,	40,	45,	48,	54,	60,	64
Relative frequency...	1,	9/8,	5/4,	4 ¹ /32*,	3/2,	27/16*,	15/8,	2
Intervals ...	9/8	10/9	9/8	16/15	9/8	10/9	16/15	

*Can the voice produce these frequencies directly?

Fig. 5.

Here G or Pa is the fundamental. Harikāmbodi. Hypo-Lydian Plagal mode. Melakarta 28.

	G	A	B	C	D	E	F	G
	36,	40,	45,	48,	54,	60,	64,	72
Relative frequency...	1,	10/9,	5/4,	4/3,	3/2,	5/3,	16/9*,	2
Intervals ...	10/9	9/8	16/15	9/8	10/9	16/15		9/8

* See difference in value from frequency obtained in probable Hanumathodi (3) scale.

† These are really notes obtained at the positions on the Pa string of a Ga interval (5/4) and a Ma interval (4/3) from Ma, if we make Ma as fundamental.

Fig. 6.

Here A or Triśruti Da is fundamental. May be Nata-Bhairavi (Melakarta 20). Asāveri *ṭhāt* in Hindustāni Hypo-Dorian Mode. (Aeolian).

A	B	C	D	E	F	G	A
40,	45,	48,	54,	60,	64,	72,	80

Relative frequency...	1,	9/8,	6/5,	27/20*,	3/2,	8/5,	9/5,	2
Intervals ...	9/8	16/15	9/8	10/9	16/15	9/8	10/9	

*Out here from the true fourth $4/3$. We have to decrease it to $4/3$; the 3rd and 4th intervals are then changed to $10/9$ and $9/8$ respectively. Then the notes are those of a minor chord (1, $6/5$, $3/2$) from Sa, Ma and Pa (1, $4/3$, $3/2$.) respectively.

Fig. 7.

Here B or Kākali Ni is fundamental. Same as practically Hanumathodi, (Fig. 3) except for the fifth.

B	C	D	E	F	G	A	B
45,	48,	54,	60,	64,	72,	80,	90

Relative frequency.	1,	16/15,	6/5,	4/3,	64/45*,	8/5,	16/9†	2
Intervals.	16/15	9/8	10/9	16/15	9/8	10/9	9/8	

This scale is discarded in use.

*Out here from true fifth.

†See difference here.

Thus, it is *perhaps* the order of semi, minor, and major tones from the fundamental or Ādhāra śruti, that gives the rāga (melody type) effect, when the drone is kept up. In a later chapter, I shall discuss the characteristics of these six rāgas of South India.

Now let us see what mathematical ratios have been obtained from this process, considering them as relative frequencies in relation to the fundamental frequency 1. We get the following 19 fractions. 1, $16/15$, $(10/9, 9/8)$, $(32/27, 6/5)$, $5/4$, $(4/3, 27/20)$, $45/32$, $64/45$, $(40/27, 3/2)$, $8/5$, $(5/3, 27/16)$, $(16/9, 9/5)$, $15/8$ and 2. The figures in brackets have the ratio of 81/80 (a comma) to each other. See Fig 8.

Fig. 8.

Values (19) found in relation to fundamental,
mathematically.

Sa ri Ri ga Ga Ma ma Pa da Da ni Ni Ša.
C d D e E F f G a A b B C.

Relative Frequencies.

$$1 \ 16/15 \ 10/9 \ 32/27 \ 5/4 \ 4/3 \ 45/32 \ 3/2 \ 8/5 \ 5/3 \ 16/9 \ 15/8 \ 2$$

$$= (4/3)^8$$

$$\begin{array}{cccccccc} \text{or} & \text{or} & \text{or} & \text{or} & \text{or} & \text{or} & \text{or} \\ 9/8 & 6/5 & 27/20 & 64/45 & 40/27 & 27/16 & 9/5 \end{array}$$

Possibilities, 5 more values (a comma flatter or sharper)
(See later)

ri	Ga	da	Ni
81 256	81/64	128	243
<hr/>	=	<hr/>	<hr/>
80 243	(9/8) ²	81	128

Discarding $81/80$ and $40/27$, since Sa and Pa cannot change in melody, the 22 śrutis given above are from the Sa Pa and Sa Ma bases.

The next question, we have to ask ourselves, is "Have these relative frequencies any definite recognizable musical values for the ear, or should one merely say that they are just slightly out from the definitely conceived musical notes in relation to the *fundamental*? If so, what are the clearly definite musical notes in relation to the fundamental, say of the vocalist? The Indian Theory is that there are definitely 22 known and recognizable pitches* within the octave. Are there not any more, which we use in melodic music? How many of these can be definitely prolonged *straight* for a decent interval of time without a quiver, or a graceful movement, or can be produced similarly on the instrument to have a sonorous effect †?

Let us now turn our attention to the difficulties in tuning the Vina, or fixing the *mela* as it is technically known. I may say that the difficulties are practically and intrinsically the same as have been met with in the tuning of the Piano. I must first mention a few facts about the

* The technical word is 'śruti'. This word has also another meaning referring to the combined music of the Drone in unison; or again we say of a musician that he sings without śruti, i.e., his music is dissonant (is not merging with Sa and Pa of the drone.) See also *Annexe to this Chapter*.

† The replies to these questions will be found in Chapter VI.

frets. They are placed on the Vina purely by a "trial and error" method. The bridge itself is broad and curved and the strings slope from the head 'meru' to the bridge so that as we go away from the bridge, the frets which give a higher pitch may not strike the string. The open playing strings are nowadays tuned in relative frequencies of 2, $3/2$, 1, and $3/4$, Sa, lower Pa, lower Sa and still lower Pa, counting from the first string nearest to the position of the player. *Vide Plate 2**.

The first frets, as I have already stated, which are placed for the Sa string are at relative frequencies 2, $3/2$, $4/3$, $5/4$ and $5/3$ (if the fundamental is taken as 1) at which upper partials are heard by just lightly touching at the point, as the fret is immediately below the string. *And every effort is made to obtain the upper partials at those points.* The corresponding points on the Pa string (Frequency $3/4$) below, will give frequencies $3/2$, $9/8$, 1, $15/16$ and $5/4$. *The positions giving upper partials on Pa string also are not changed.*

Foot-note. Hence the statement made by Mr. Fox Strangways in his essay on Music in "Legacy of India" (page 311), Oxford Clarendon Press, that the Indian regards $27/16$ (A +) as the natural note, while the European regards $5/3$ as the natural note is fully *disproved* by the actual position of the frets in the *South Indian Vina* of Dhaivata or A.

*The bottom strings twanged for rhythm are tuned at frequencies 2, 3 and 4 if the first playing string nearest the player is taken as 2, i.e., Sa Pa Sa if the said first string is Sa.

I shall now state what the upper partials referred to are. They are better understood by reference to the violin itself. The South Indian tunes the strings of the violin as Sa Pa and Śa Ṗa, the silver string being Sa of the first octave, then the two catgut strings being the Pa and Śa and lastly the steel string being Ṗa, *i.e.*, at relative frequencies of 1, $3/2$, 2 and 3 respectively, that is, as octaves of the first and true fifths of the fundamental.

The reason why he tunes the violin thus is to be found in the fact that he desires the occasional effect of the drone in his ear, so essential for melody.

If the silver string and Pa string are bowed powerfully together, one can see the whole silver string vibrating in one, two, three, four or five loops or at least their nodal points dying out. If the silver string vibrates in one single loop, the fundamental Sa is heard. If the player lightly touches the middle point, the vibrating string will appear in two loops, and the note Śa (relative frequency 2) is heard, which is really the fundamental note of the catgut string next to the steel string. If he lightly touches the silver string at the third aliquot part from below, he will hear the Ṗa of the higher octave, relative frequency 3, which is the fundamental note produced by the open steel string.

If he lightly touches at the fourth aliquot part of the silver string from below, the silver string will divide itself into four loops and he will hear the still higher Sa or Śa, relative frequency 4, the beginning of the next but one octave from the fundamental of the silver string, or what will be produced by pressing *tightly* on the steel string Pa at a fourth aliquot part from below.

If he lightly touches the silver string at the fifth aliquot part from below, he will hear $\dot{G}a$, that is relative frequency 5, *i.e.*, a major third higher than $\dot{S}a$ referred to in the previous para. It will be the Ga above the *second* octave from the Sa of the silver string.

On some occasions, at the fifth aliquot of the silver string, if one slightly lowers the point touched by a millimetre, one can hear a very high Pa , frequency 6 probably. I do not know the reason thereof.

If one similarly lightly touches at $2/5$ ths of the silver string from below, one will hear the $\dot{G}a$, relative frequency 5 above the second octave, just exactly the same note as that produced by touching lightly the string at the aliquot part $1/5$ from below. But the note produced by pressing at that point, that is, if $3/5$ ths of the string alone vibrates without the bottom portion doing so, will be the *Trisruti* *Dhaivata* of relative frequency $5/3$ (or A).

If one plays the Pa string similarly, that is the catgut string next to the silver string, one will hear when *lightly* touched at its aliquot parts $1/2$, $1/3$, $1/4$, $1/5$, and at $2/5$ ths from below, or the head, the notes $\dot{P}a$ $\dot{R}i$ $\dot{P}\ddot{a}$ $\dot{N}i$ $\dot{N}\ddot{i}$ of relative frequencies 3, $9/2$, 6, and $15/2$ and $15/2$, respectively.

Now let us turn to the placing of the frets on the *Vina*. But before I actually do so, I may notice certain facts about the harmonium or the piano. The reader will have realized that if Sa is the fundamental with frequency 1, then *Suddha Madhyama* has relative frequency of $4/3$ and *Pañchama* of $3/2$. They are true fourths and fifths of the fundamental.

One can make no mistake at all about these svaras **Suddha Madhyama** and **Pañchama**, as each coalesces with **Sa**.

Let us proceed on the harmonium or the piano by raising our pitches from the first white key, by going up the **Sa-Pa** method or by intervals of **Pa** from each note obtained. If we proceed from **Pa** by a **Pa** interval, we get the **Chatuśruti Ri** key. Here we *drop an octave*, and if from the **Chatuśruti Ri** in the 1st octave we proceed an interval of **Pa**, we get the **Chatuśruti Da** key. Of course, I mention the names of these notes as in *common parlance*. Then, on a further **Pa** interval, we get the key of **Antara Gāndhāra**; we *drop an octave*, here, *i. e.*, to the same key in the 1st octave; go a further **Pa**, and we get **Kākali Nishāda**; on a further **Pa**, we get **Prati madhyama** of the higher octave, *drop an octave* here, and on a further **Pa**, we reach **Suddha rishaba** (**Karnātic**); we again *drop an octave*; on a further **Pa** we get **Suddha dhaivata** (**Karnātic**), then by a further **Pa** we reach **Sādhārana gāndhāra**; again *drop an octave*, a further **Pa** takes us to **Kaisiki nishāda**; then by further **Pa** we reach **Suddha Madhyama**; again *drop an octave* to **Suddha Madhyama** in the 1st octave and go up a **Pa** interval, we then get the higher **Śa**.

So, *roughly*, by proceeding by **Pa** intervals, the twelve notes (pitches) in the octave are reached, dropping where necessary, an octave, when we are getting on to the higher octave.

Similarly, if one proceeds by an interval of **Suddha Madhyama** from **Shadja**, the first note will be **Suddha Madhyama**, the next will be **Kaisiki nishāda**, the next will

be Sādhārana gāndhāra, reaching in order Suddha dhaivata, Suddha rishaba, Prati madhyama, Kākali Nishāda, Antara Gāndhāra, Chaturśruti Dhaivata, Chaturśruti Rishaba and then Pañchama, and one finally can come back to the Sa itself; but we must of course drop some four octaves in the process.

Let us *mathematically* examine this position to see if it is perfectly correct. The following table will show that we are slightly *out* in this process, as can be seen from the working.

A i. Sa $1 \times 3/2 = 3/2 = \text{Pa}$

ii. $3/2 \times 3/2 = 9/4$

Here we *drop an octave*, i.e., divide by 2; we have $9/8$ Ri.

iii. $9/8 \times 3/2 = 27/16$, that is Da.

iv. $27/16 \times 3/2 = 81/32$

Here we *drop an octave*, we have $81/64$ (Antara Gāndhāra, sharper by a comma, (Rel. freq. $81/80$) than $5/4$.)

v. $81/64 \times 3/2 = 243/128$, Kākali Nishāda, a comma sharper than $15/8$.

vi. $243/128 \times 3/2 = 729/256$

Here we *drop an octave*, we have $729/512$.

We have to equate this to $64/45$, Prati madhyama, the reason for which I shall explain later, as the difference is small and not distinguishable.

vii. $64/45 \times 3/2 = 32/15$

Here we *drop an octave*, and have $16/15$ Suddha rishaba.

viii. $16/15 \times 3/2 = 8/5$ Suddha dhaivata

ix. $8/5 \times 3/2 = 12/5$

Here *drop an octave*, we have $6/5$ Sādhārana gāndhāra.

x. $6/5 \times 3/2 = 9/5$ Kaisiki nishāda

xi. $9/5 \times 3/2 = 27/10$

Here *drop an octave*, we have $27/20$, which is a comma sharper than Suddha Madhyama $4/3$.

$$27/20 \times 3/2 = 81/40$$

Here *drop an octave*, we have $81/80$, a comma sharper than Sa.

Similarly, if one goes up by Suddha Madhyama intervals, from Shadja, we have the following calculations.

B i. $1 \times 4/3 = 4/3$ Suddha Madhyama.

ii. $4/3 \times 4/3 = 16/9$ Kaisiki nishāda, a comma $81/80$ flatter than Kaisiki nishāda, obtained in the previous calculation.

iii. $16/9 \times 4/3 = 64/27$

Here *drop an octave*, we have $32/27$ Sādhārana gāndhāra, a comma flatter than the Sādhārana gāndhāra obtained in the previous calculation.

iv. $32/27 \times 4/3 = 128/81$, we have Suddha dhaivata, a comma flatter than $8/5$ obtained in the previous calculation.

v. $128/81 \times 4/3 = 512/243$

Here *drop an octave*, we have $256/243$, that is a comma flatter than $16/15$ Suddha rishaba obtained in the previous calculation.

vi. $256/243 \times 4/3 = 1024/729$. Here we equate this as equal to $45/32 = \text{Prati madhyama}$, holding the relation of Kākali Nishāda (or $15/8$) of Pañchama.

vii. $45/32 \times 4/3 = 15/8$ or Kākali Nishāda

viii. $15/8 \times 4/3 = 5/2$

Here *drop an octave*, we have $5/4$ or Antargata Gāndhāra.

ix. $5/4 \times 4/3 = 5/3$ Triśruti Dhaivata, or a comma below Chatusruti Dhaivata $27/16$

x. $5/3 \times 4/3 = 20/9$

Here *drop an octave*, we have $10/9$ Triśruti Ri, that is a comma flatter than Chatusruti Ri $9/8$.

xi. $10/9 \times 4/3 = 40/27$, or a comma flatter than Pañchama $3/2$.

It is thus easily seen that in the tuning of the Piano, or the harmonium, we cannot get all the twelve pitches correctly in the relation either Sa—Ma or of Sa—Pa.

The European theory of Piano tuning is that each note must bear the same ratio to the next higher note among the twelve keys; that is, the musical interval between each key is really the 12th root of 2. If you denominate the logarithm of the number 2 as equal to 1,200 cyclic cents, each of these 12 notes of Sa, ri, Ri etc. flats and sharps would rise by 100 cents, that is, each of the corresponding notes will have relative frequencies of 2^0 , $2^{1/12}$, $2^{2/12}$, $2^{3/12}$, and so on, or in logarithmic cyclical

cents of 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, 1,100 and 1,200 being the octave.

The following paras and figs. 9-10 may not be read by any one who does not know logarithms.

Now we can easily work out the frequency $3/2$ as equal to 702 cents.

Working.

The ratio of $\log 3/2$ to $\log 2 = x$: 1,200.

$$x = \frac{1,200 \times \log 1.5}{\log 2} = \frac{1,200 \times .1760913}{.3010300}$$

$$\log .1760913 = \bar{1}.2457421$$

$$\log 1,200 = 3.0791812$$

$$\text{Add} \quad 2.3249233$$

$$\text{Subtract log } .30103 \quad \bar{1}.4786098$$

$$\log x = 2.8463135$$

$$\text{or } x = 701.962 \text{ or } 702 \text{ in cyclic cents.}$$

Similarly, the frequency $4/3$ can be calculated to be equal to 498 cents. Thus the octave is seen by addition to be 1,200 cents.

Now the ascent of the pitches by the Sa-Pa and Sa-Ma bases can be also worked out by logarithmic cents.

Fig. 9.

Sa.—Pa

- i. $0 + 702 = 702 = (3/2)$
- ii. $702 + 702 = 1,404$; deduct 1,200
 $204 = 9/8$
- iii. $204 + 702 = 906 = 27/16 = 884 + 22$
- iv. $906 + 702 = 1608$; deduct 1,200
 $408 = 81/64 = 5/4 \times 81/80$
 $= 386 + 22$
- v. $408 + 702 = 1,110$ or $1,200 - 112 + 22$; $(15/8 \times 81/80)$
 $= 243/128$.
- vi. $1,110 + 702 = 1,812$; deduct 1,200
 612 ; drop 2 cents
 $610 = 64/45$.
- vii. $610 + 702 = 1,312$; deduct 1,200
 $112 = 16/15$
- viii. $112 + 702 = 814 = 8/5$
- ix. $814 + 702 = 1,516$; deduct 1,200
 $316 = 6/5$
- x. $316 + 702 = 1,018 = (1,200 - 182)$
 $= 9/5$
- xi. $1,018 + 702 = 1,720$; deduct 1,200
 520
 $= (498 + 22) = 27/20$
or $4/3 \times 81/80$, a comma above Ma
- xii. $520 + 702 = 1,222$
deduct 1200; we have $22 = 81/80$
a comma above Sa

Fig. 10.

Sa—Ma

- i. $0 + 498 = 498 = 4/3$
- ii. $498 + 498 = 996 = 16/9$ or $(1,200-204) = 2 \div 9/8$
- iii. $996 + 498 = 1494$
deduct 1,200 or $294 = 32/27$
- iv. $294 + 498 = 792 = 128/81$
- v. $792 + 498 = 1,290$
deduct 1,200
 $90 = 256/243$
- vi. $90 + 498 = 588$
Add 2 cents here
590
 $= 45/32$ (or $3/2 \div 16/15$)
- vii. $590 + 498 = 1,088 = 15/8$
- viii. $1,088 + 498 = 1,586$
deduct 1,200
 $386 = 5/4$
- ix. $386 + 498 = 884 = 5/3$
- x. $884 + 498 = 1,382$
deduct 1,200
 $182 = 10/9$.
- xi. $182 + 498 = 680$ or $702-22$
or $3/2 \div 81/80$
or $40/27$, a comma less sharp than Pa.

We have equated in the method of direct calculation, relative frequencies of $729/512$ and $64/45$. Their relationship is equal to

$$\frac{729 \times 45}{512 \times 64} \text{ or } \frac{32805}{32768} \text{ (called a sikhshma)}$$

Similarly, in the other calculation we have equated 1024/729 and 45/32. Here also the ratio is

$$\frac{1024 \times 32}{729 \times 45} \text{ or } \frac{32805}{32768}$$

that is the same ratio as above. This works out to barely 2 cents difference, and is hardly distinguishable by the finest ear.

A preliminary question may be asked whether there were any musical terms to define musical intervals, prior to the determination by Physicists of the relative frequencies. Yes. The intervals were called, as I have already said, major tones, minor tones and semi-tones. An octave is made up, as we can see now, of three major tones, two minor tones and two semi-tones. Similarly, by the current use of the word "Chatuśruti" Rishabha in South Indian music which is stated to be the relation of Ma to Pa, from Sa, meaning thereby four śrutis, we may perhaps conceive that the Indian was also conscious of the terms Triśruti and dvīśruti, meaning three and two śrutis respectively, to represent these three intervals of the major, minor and semi-tones.

The actual method of tuning the piano is to proceed by the true fifths and by the true fourths and then to split the difference of 24 cents of the octave, which results in these two processes among the twelve keys, by count of beats and the test of the smoothness of the major chords. The same problem, seeing that the strings are tuned as Sa Pa, does present itself in the tuning of the Vina. And if we are to proceed alike in the fretting of the Vina, we should come to this very trouble, and we would never have been able to fix them at any *natural* notes. The Tanjore musician has

actually fixed the twelve frets on the Sa string in the octave at the *lower* of the two *twin* frequencies, except for $16/15$ and $8/5$. The Vina frets, *as estimated by musical comparison* on the Sa string are at relative frequencies 1, (the open string) $16/15$, $10/9$, $32/27$, $5/4$, $4/3$, $45/32$, $3/2$, $8/5$, $5/3$, $16/9$, $15/8$, and 2. *We cannot evaluate these values on the lengths of the strings as the bridge is broad, and the point of contact cannot be exactly determined.*

If you see Fig. 11, at Page 29, you would observe that the tuner goes backwards from Ga on the Sa string to lower Da on Pa string *i.e.*, from $5/4$ to half of $5/3$. ($1/2 \times 5/4 \times 4/3$); and then he fixes the Ri $10/9$ on Sa string ($5/6 \times 4/3$). Similarly, he goes back from Ma to ni fixing the ni at half of $16/9$, and the ga would be corresponding to the frequency $32/27$. He similarly comes *forward* from Ni, half of $15/8$ to ma $45/32$ ($1/2 \times 15/8 \times 3/2$) ma sharp.

If we now just evaluate what would be the notes on the Pa string, we will find them to be of the following values.

	Pa	da	Da	ni	Ni	Sa	ri	Ri
$1/2$ of	$(3/2,$	$8/5,$	$5/3,$	$16/9,$	$15/8,$	$2)$	$135/128,$	$9/8,$
	ga	Ga	Ma	ma	Pa			
	$6/5,$	$5/4,$	$4/3,$	$45/32,$	$3/2.$			

so that even among the frets which compare with ri Ri ga, with values of $135/128$, $9/8$, and $6/5$, it is seen they do *not* tally with ri, Ri, ga, of values $16/15$, $10/9$, and $32/27$ placed on the Sa string. The reader who has followed me so far may just observe that I have in this chapter merely elaborated what has been stated perhaps in less than a dozen lines

[illegible]

up. = upper
s = length of
string 300

Bridge

718 M

3

2

1000

12

2/1

— 1/4 — 1/2 — 3/4 — 1 — 1 1/4 — 1 1/2 — 1 3/4 — 2 — 2 1/4 — 2 1/2 — 2 3/4 — 3 — 3 1/4 — 3 1/2 — 3 3/4 — 4 — 4 1/4 — 4 1/2 — 4 3/4 — 5 — 5 1/4 — 5 1/2 — 5 3/4 — 6 — 6 1/4 — 6 1/2 — 6 3/4 — 7 — 7 1/4 — 7 1/2 — 7 3/4 — 8 — 8 1/4 — 8 1/2 — 8 3/4 — 9 — 9 1/4 — 9 1/2 — 9 3/4 — 10 — 10 1/4 — 10 1/2 — 10 3/4 — 11 — 11 1/4 — 11 1/2 — 11 3/4 — 12 — 12 1/4 — 12 1/2 — 12 3/4 — 13 — 13 1/4 — 13 1/2 — 13 3/4 — 14 — 14 1/4 — 14 1/2 — 14 3/4 — 15 — 15 1/4 — 15 1/2 — 15 3/4 — 16 — 16 1/4 — 16 1/2 — 16 3/4 — 17 — 17 1/4 — 17 1/2 — 17 3/4 — 18 — 18 1/4 — 18 1/2 — 18 3/4 — 19 — 19 1/4 — 19 1/2 — 19 3/4 — 20 — 20 1/4 — 20 1/2 — 20 3/4 — 21 — 21 1/4 — 21 1/2 — 21 3/4 — 22 — 22 1/4 — 22 1/2 — 22 3/4 — 23 — 23 1/4 — 23 1/2 — 23 3/4 — 24 — 24 1/4 — 24 1/2 — 24 3/4 — 25 — 25 1/4 — 25 1/2 — 25 3/4 — 26 — 26 1/4 — 26 1/2 — 26 3/4 — 27 — 27 1/4 — 27 1/2 — 27 3/4 — 28 — 28 1/4 — 28 1/2 — 28 3/4 — 29 — 29 1/4 — 29 1/2 — 29 3/4 — 30 — 30 1/4 — 30 1/2 — 30 3/4 — 31 — 31 1/4 — 31 1/2 — 31 3/4 — 32 — 32 1/4 — 32 1/2 — 32 3/4 — 33 — 33 1/4 — 33 1/2 — 33 3/4 — 34 — 34 1/4 — 34 1/2 — 34 3/4 — 35 — 35 1/4 — 35 1/2 — 35 3/4 — 36 — 36 1/4 — 36 1/2 — 36 3/4 — 37 — 37 1/4 — 37 1/2 — 37 3/4 — 38 — 38 1/4 — 38 1/2 — 38 3/4 — 39 — 39 1/4 — 39 1/2 — 39 3/4 — 40 — 40 1/4 — 40 1/2 — 40 3/4 — 41 — 41 1/4 — 41 1/2 — 41 3/4 — 42 — 42 1/4 — 42 1/2 — 42 3/4 — 43 — 43 1/4 — 43 1/2 — 43 3/4 — 44 — 44 1/4 — 44 1/2 — 44 3/4 — 45 — 45 1/4 — 45 1/2 — 45 3/4 — 46 — 46 1/4 — 46 1/2 — 46 3/4 — 47 — 47 1/4 — 47 1/2 — 47 3/4 — 48 — 48 1/4 — 48 1/2 — 48 3/4 — 49 — 49 1/4 — 49 1/2 — 49 3/4 — 50 — 50 1/4 — 50 1/2 — 50 3/4 — 51 — 51 1/4 — 51 1/2 — 51 3/4 — 52 — 52 1/4 — 52 1/2 — 52 3/4 — 53 — 53 1/4 — 53 1/2 — 53 3/4 — 54 — 54 1/4 — 54 1/2 — 54 3/4 — 55 — 55 1/4 — 55 1/2 — 55 3/4 — 56 — 56 1/4 — 56 1/2 — 56 3/4 — 57 — 57 1/4 — 57 1/2 — 57 3/4 — 58 — 58 1/4 — 58 1/2 — 58 3/4 — 59 — 59 1/4 — 59 1/2 — 59 3/4 — 60 — 60 1/4 — 60 1/2 — 60 3/4 — 61 — 61 1/4 — 61 1/2 — 61 3/4 — 62 — 62 1/4 — 62 1/2 — 62 3/4 — 63 — 63 1/4 — 63 1/2 — 63 3/4 — 64 — 64 1/4 — 64 1/2 — 64 3/4 — 65 — 65 1/4 — 65 1/2 — 65 3/4 — 66 — 66 1/4 — 66 1/2 — 66 3/4 — 67 — 67 1/4 — 67 1/2 — 67 3/4 — 68 — 68 1/4 — 68 1/2 — 68 3/4 — 69 — 69 1/4 — 69 1/2 — 69 3/4 — 70 — 70 1/4 — 70 1/2 — 70 3/4 — 71 — 71 1/4 — 71 1/2 — 71 3/4 — 72 — 72 1/4 — 72 1/2 — 72 3/4 — 73 — 73 1/4 — 73 1/2 — 73 3/4 — 74 — 74 1/4 — 74 1/2 — 74 3/4 — 75 — 75 1/4 — 75 1/2 — 75 3/4 — 76 — 76 1/4 — 76 1/2 — 76 3/4 — 77 — 77 1/4 — 77 1/2 — 77 3/4 — 78 — 78 1/4 — 78 1/2 — 78 3/4 — 79 — 79 1/4 — 79 1/2 — 79 3/4 — 80 — 80 1/4 — 80 1/2 — 80 3/4 — 81 — 81 1/4 — 81 1/2 — 81 3/4 — 82 — 82 1/4 — 82 1/2 — 82 3/4 — 83 — 83 1/4 — 83 1/2 — 83 3/4 — 84 — 84 1/4 — 84 1/2 — 84 3/4 — 85 — 85 1/4 — 85 1/2 — 85 3/4 — 86 — 86 1/4 — 86 1/2 — 86 3/4 — 87 — 87 1/4 — 87 1/2 — 87 3/4 — 88 — 88 1/4 — 88 1/2 — 88 3/4 — 89 — 89 1/4 — 89 1/2 — 89 3/4 — 90 — 90 1/4 — 90 1/2 — 90 3/4 — 91 — 91 1/4 — 91 1/2 — 91 3/4 — 92 — 92 1/4 — 92 1/2 — 92 3/4 — 93 — 93 1/4 — 93 1/2 — 93 3/4 — 94 — 94 1/4 — 94 1/2 — 94 3/4 — 95 — 95 1/4 — 95 1/2 — 95 3/4 — 96 — 96 1/4 — 96 1/2 — 96 3/4 — 97 — 97 1/4 — 97 1/2 — 97 3/4 — 98 — 98 1/4 — 98 1/2 — 98 3/4 — 99 — 99 1/4 — 99 1/2 — 99 3/4 — 100 — 100 1/4 — 100 1/2 — 100 3/4 — 101 — 101 1/4 — 101 1/2 — 101 3/4 — 102 — 102 1/4 — 102 1/2 — 102 3/4 — 103 — 103 1/4 — 103 1/2 — 103 3/4 — 104 — 104 1/4 — 104 1/2 — 104 3/4 — 105 — 105 1/4 — 105 1/2 — 105 3/4 — 106 — 106 1/4 — 106 1/2 — 106 3/4 — 107 — 107 1/4 — 107 1/2 — 107 3/4 — 108 — 108 1/4 — 108 1/2 — 108 3/4 — 109 — 109 1/4 — 109 1/2 — 109 3/4 — 110 — 110 1/4 — 110 1/2 — 110 3/4 — 111 — 111 1/4 — 111 1/2 — 111 3/4 — 112 — 112 1/4 — 112 1/2 — 112 3/4 — 113 — 113 1/4 — 113 1/2 — 113 3/4 — 114 — 114 1/4 — 114 1/2 — 114 3/4 — 115 — 115 1/4 — 115 1/2 — 115 3/4 — 116 — 116 1/4 — 116 1/2 — 116 3/4 — 117 — 117 1/4 — 117 1/2 — 117 3/4 — 118 — 118 1/4 — 118 1/2 — 118 3/4 — 119 — 119 1/4 — 119 1/2 — 119 3/4 — 120 — 120 1/4 — 120 1/2 — 120 3/4 — 121 — 121 1/4 — 121 1/2 — 121 3/4 — 122 — 122 1/4 — 122 1/2 — 122 3/4 — 123 — 123 1/4 — 123 1/2 — 123 3/4 — 124 — 124 1/4 — 124 1/2 — 124 3/4 — 125 — 125 1/4 — 125 1/2 — 125 3/4 — 126 — 126 1/4 — 126 1/2 — 126 3/4 — 127 — 127 1/4 — 127 1/2 — 127 3/4 — 128 — 128 1/4 — 128 1/2 — 128 3/4 — 129 — 129 1/4 — 129 1/2 — 129 3/4 — 130 — 130 1/4 — 130 1/2 — 130 3/4 — 131 — 131 1/4 — 131 1/2 — 131 3/4 — 132 — 132 1/4 — 132 1/2 — 132 3/4 — 133 — 133 1/4 — 133 1/2 — 133 3/4 — 134 — 134 1/4 — 134 1/2 — 134 3/4 — 135 — 135 1/4 — 135 1/2 — 135 3/4 — 136 — 136 1/4 — 136 1/2 — 136 3/4 — 137 — 137 1/4 — 137 1/2 — 137 3/4 — 138 — 138 1/4 — 138 1/2 — 138 3/4 — 139 — 139 1/4 — 139 1/2 — 139 3/4 — 140 — 140 1/4 — 140 1/2 — 140 3/4 — 141 — 141 1/4 — 141 1/2 — 141 3/

length of string from

Metu.	20 m	60 m	7 1/2 m.	100 m
Metu.	20 m	60 m	7 1/2 m.	100 m

in Helmholtz's "Sensations of Tone" (Ellis' Translation), pages 280 and 281, 5th Edition. But I have done so with a purpose, as he will see in the succeeding chapters.

Two tables below give definite names to the 22 frequencies, which have just been obtained. Of course, we ignore the ratios 81/80 and 40/27, which we have obtained in this process, because for melodic purposes, Sa and Pa can never be changed. We must *probably* expect variations in the other *ten* pitches in the octave, which have been placed on the frets of the Vina, and which the voice might actually find it easy to follow in melody.

TABLE III.

Relationship of Shadja (Sa)	Pañchama (Pa) among śrutis	Sign.	Frequency within octave.
1	2	3	4
Shadja = Sa = 1	Pañchama = 3/2	Pa	3/2
Pañchama	Chatuśruti Rishaba	Ri ₂	9/8
Chatuśruti Ri	Chatuśruti Dhaivata	Da ₂	27/16
Chatuśruti Dha	Tivra Gāndhāra	Ga ₂	81/64
Tivra Gāndhāra	Tivra Nishāda	Ni ₂	243/128
Tivra Nishāda	Tivra tara madh- yama	ma ₂	64/45
Tivra tara madh- yama	Dviśruti rishaba	ri ₂	16/15
Dviśruti rishaba	Dviśruti dhaivata	da ₂	8/5
Dviśruti dhaivata	Sādhārana gāndhāra	ga ₂	6/5
Sādhārana gāndhāra	Kaisiki nishāda	ni ₂	9/5
Kaisiki nishāda	Tivra Madhyama (a comma sharper than Ma ₁)	Ma ₂	27/20

Relationship of Shadja Suddha Madhyama among Śrutis

Shadja Sa = 1.	Suddha Madhyama	Ma ₁	4/3
Suddha Madhyama	Madhya nishāda	ni ₁	16/9
Madhya nishāda	Madhya gāndhāra	ga ₁	32/27
Madhya gāndhāra	Ekaśruti dhaivata	da ₁	128/81
Ekaśruti dhaivata	Ekaśruti rishaba	ri ₁	256/243
Ekaśruti rishaba	Prati madhyama	ma ₁	45/32
Prati madhyama	Kākali Nishāda	Ni ₁	15/8
Kākali Nishāda	Antargata Gāndhāra	Ga ₁	5/4
Antargata Gāndhāra	Triśruti Dhaivata	Da ₁	5/3
Triśruti Dhaivata	Triśruti Rishaba	Ri ₁	10/9
Triśruti Rishaba	(a note which is a comma 81/80 flatter than Pa)		40/27

N. B.—These are the values which have been given by Fox Strangways in his book "The Music of Hindustān" and in 'the Legacy of India' Oxford University Press (1937) already quoted, also by Dr. Robert Lachmann in 'Zeitschrift Fur verg leichende Musikwissenschaft, January 1933 in the article "Indische Tonsystem Bei Bharata".

A reference is now invited to Fig 8, and it will be noticed that 22 srutis have been denoted in the 18 ratios in the top part, and 4 others in the line below.

I shall use the indexes to the twelve symbols given in the Preliminary note, where I am particular regarding the pitch used in the melody.

Note added in 2nd Edition. To my mind, the theory of 22 śrutis etc., may have been confirmed on a 'Svara Mandal' extant to-day alike the Aeolian Lyre. The problem to-day is associated with the choice of one from each of the 12 twin ratios for the 12 frets of the Vina on the Sa string.

TABLE IV.

(Same as Table III except that the arrangement is in the order of pitch.)

	Frequency Ratio	Cyclic cents	Symbol	
Shadja	1	0	Sa	
1 Ekaśruti rishaba	256/243*	90	ri ₁	
2 Dviśruti rishaba	16/15	112	ri ₂	
3 Triśruti Rishaba	10/9	182	Ri ₁	
4 Chatuśruti Rishaba	9/8	204	Ri ₂	
5 Madhya gāndhāra	32/27*	294	ga ₁	
6 Sādhārana gāndhāra	6/5	316	ga ₂	
7 Antargata Gāndhāra	5/4	386	Ga ₁	
8 Tivra Gāndhāra	81/64*	408	Ga ₂	
9 Suddha Madhyama	4/3	498	Ma ₁	
10 Tivra Madhyama	27/20*	520	Ma ₂	
11 Prati madhyama	45/32*	590	ma ₁	} Dif. 20 Cents only.
12 Tivra tara madhyama	64/45*	610	ma ₂	
13 Pañchama	3/2	702	Pa	
14 Ekaśruti dhaivata	128/81*	792	da ₁	
15 Dviśruti dhaivata	8/5	814	da ₂	
16 Triśruti Dhaivata	5/3	884	Da ₁	
17 Chatuśruti Dhaivata	27/16	906	Da ₂	
18 Madhya nishāda	16/9*	996	ni ₁	
19 Kaisiki nishāda	9/5	1018	ni ₂	
20 Kākali Nishāda	15/8	1088	Ni ₁	
21 Tivra Nishāda	243/128*	1110	Ni ₂	
22 Tāra Shadja (higher)	2	1200	Sa	

When a European musician hears Indian melodies, he usually observes that the Indian uses quarter tones. Whether any one has determined scientifically the exact value of the quarter tone is the next question.

I have already introduced to you the word small semi-tone; and in Helmholtz's "Sensations of Tone" Ellis' translation, a small semi-tone is stated to represent the frequency ratio of $25/24$. Whether this ratio is *actually* in use by us has to be scientifically determined (*vide* appendix). Yet we do not find the *small-semi-tone* interval between the *twin* frequencies obtained in this chapter. I doubt if the human voice in current melodic music ever *directly* reaches the notes of these *complex* fractions like $256/243$, $32/27$, $81/64$, $27/20$, $45/32$, $64/45$, $128/81$, $16/9$, and $243/128$ (asterisked) in Table IV, when the drone is kept up.

Let me give the reader also a hint as to how a distinction can be realised between the Triśruti Ri (Frequency $10/9$) and the Chaturśruti Ri (Frequency $9/8$), which are both formed at aliquot parts of the Sa string at $1/10$ th and $1/9$ th from the head. I have already said that Chaturśruti Ri should be sounded as a Pa interval from (lower) Ṣa. The Triśruti Ri can best be recognized by pronouncing Suddha Madhyama and dropping to Ri immediately. Then he will find that he drops a *minor third* interval of frequency $6/5$, and the note $10/9$ is reached. For example, in 'Viriboni' Aṭa tāla varṇa in rāga Bhairavi of South India, when we say ṇi, Sa, Ri, . . , the Ri which is very prolonged is Triśruti. Unfortunately, it is made to coalesce with (lower) Ṣa on the violin, but this should *not* be done so for a better realization of the Rāgabhāva. I may add another instance. When we say in the Yādakula Kāmbodī | Sa Ri Ga, Ga, | the Ri must be Triśruti ($10/9$) to produce the proper effect whereas when we play Sankarābharana, | Sa, Ri Ga | Ma Pa,—the Ri will rise to the Chaturśruti.

In this scheme, as formulated by Fox Strangways and others, three important musical notes $7/6$, $7/4$, and $7/5$, are missing if we restrict ourselves to the scheme of 22 śrutis on Sa-Ma, Sa-Pa bases only. I recognize them by their resonance and upper partials as I play them on the violin. They are beautiful notes, and are certainly in use in South Indian melodies. These are all prolongable notes also, and I shall refer to them later. (See Page 39).

The South Indian might ask me in what niches I have to place the svaras Suddha gāndhāra and Suddha nishāda, and svaras *Shadśruti* Rishaba and *Shadśruti* Dhaivata, names given to certain notes in the 72 Mela Rāga scheme, (See Chapter XI).

After listening to the composition *Mela Rāga Mālīka* of the late Maha Vaidyanatha Sivan, as sung by his pupil Vidvan Sri Sabhesa Iyer, I have come to the following conclusion.

	Commonly stated to be	My opinion
1 Suddha gāndhāra	Chatuśruti Rishabha	Trisruti Rishabha (10/9)
2 Suddha nishāda	Chatuśruti Dhaivata	Trisruti Dhaivata (5/3)
3 Shad-śruti Rishabha	Sādhārana gāndhāra	Frequency $6/5$ harmonic on Sa string
4 Shad-śruti Dhaivata	Kaisiki nishāda	Frequency $9/5$ harmonic on Pa string

The word Shad meaning 'six' tallies with my interpretation as the *sixth* note in the scheme of notes obtain-

ed from Sa-Pa and Sa-Ma bases, since Chatusruti Ri is the 4th Ri.

Thus it appears logical that the svaras, Suddha rishabha (16/15) and Suddha gāndhāra (10/9), of South Indian nomenclature, are obtained by the *inversion* or a drop of a major third (5/4) and a harmonic minor third (6/5) respectively from Suddha Madhyama (4/3). Similarly, Suddha dhaivata (8/5) and Suddha nishāda (5/3) are derived by similar *inversions* from higher Shadja (2).

ANNEXE TO CHAPTER I

The śruti intervals, as the ancient texts are explained by Fox Strangways and others, are *not* treated as of equal extent. But each interpreter has his own frequency values to accord for the twenty-two Śrutis. The fact remains that the drone has to be maintained by every vocalist or instrumentalist to effect the consonance therewith. Clearly enough therefore, the extreme end-svaras of the Gamakas (movements) have to merge with Sa or Pa of the drone. Since definite names have been assigned to the śrutis in the past, I prefer to treat them as recognisable pitches of a *harmonic* series, as I shall explain later, at least so far as present-day music is concerned.

CHAPTER II GAMAKAS AND SRUTIS.

The reader, who has gone through the last Chapter may ask "Why all this fuss about fractional ratios*?".

* In this book, I shall hereafter refer to frequency ratio numbers, instead of cyclic cents or vibrational values, as these small fractions, numbering 30 or 32, are easy to remember and convey their meaning better to the mind.

Do I play melodies with the consciousness of these fractional ratios?" Certainly not. "Why should not the instrumentalists simply follow the human voice and be done with it?" True, on the stringed instruments, which have no frets, the movements are to a large extent indeterminate and just a matter of practice; but in the Vina itself, the pull has got to be exerted sometimes from the lower frets to produce the required pitch, as the note on the next fret seems to be higher than that produced at a certain moment by the human voice in a rāga. I am aware that even from the same fret of the Vina, the pitch is varied to the extent of four or more svaras. But I am referring to facts like that Sādhārana gāndhāra of Karnātic Todi is produced from the Ri fret, the da of Sāveri, from Pa and so on. So also does the violinist vary his technique by a manipulation of the tension of the strings and the slightly different position of the fingers for each svara for slides etc., when thus a secondary sensory impression of the sense of touch supervenes. The enquiring mind asks the question, "Is there any law or symmetry in this pulling across the fret, and what is the extent of the pull?" Though for practical purposes of notation, the 12 frets and 12 names may be deemed sufficient, should we not for a realization of the 'Rāga', art-form, have a fuller elaboration?

While dealing with this subject of śruti, I cannot but refer to certain attempts in India to produce a harmonium with 22 keys to the octave so that they may find a substitute for the stringed instrument, for the harmonium is easy to learn. But this much I can say,

that these 22 keys will not suffice to produce the melodious effect of the Vina or the Violin in imitating the nuances and the continuity of the human voice ; again because the 22 keys in each octave should have to be fixed for each fundamental pitch of any one singer and it cannot be made to suit singers in other pitches. Further, one cannot definitely affirm when the *twin note* does come in and I am afraid all spontaneity will be lost by the large number of frets. I only ask, why not learn the Vina or the Violin itself and consign to the dust heap the harmonium, instead of attempting to refine it ? But even then, as I shall have pointed out before the end of this discourse, these 22 śrutis, which would be got by the Sa Ma and Sa Pa bases, are not always correct in their application to vocal music, for again, *music works itself into a pattern like a chain not easily resolvable.*

Some may have read Tolstoi's book, "What is Art ?" Many critics do not agree with his views, but I fully concur with his observations about music. He writes, "Art begins where the wee bit begins, so far as music is concerned." "Musical execution is only then art, when the sound is neither higher nor lower than it should be, *i.e.*, when exactly the infinitely small centre of the required note is taken etc. No instruction can make the singer or fiddler take exactly the infinitely small centre of this note, and this is found only by perception." "The teaching of the schools stops where the wee bit begins, and consequently where art begins." The idea of the wee bit so finely expressed is to be found in our conception of śrutis, which present-day artists should do well to understand. The light and shade in the delineation of Rāgas, the basis of our

Art music, depends on these small microtonal changes in the 12 *svara-sthānās* or *fret positions*.

In the last chapter, I referred to the fundamental and its upper partials. The whole texture of the tone of a vibrating string is the result of some sort of mixing up of all the notes of various pitches. They can be separated by Helmholtz's Globes.

It is said that the human voice has as many as *sixteen* upper partials, though the intensity of the higher pitches must be fastly decreasing (as we go up) to a very small figure. If 1 is the fundamental, the pitches which merge in it are 2, 3, 4, 5, 6, 7, 8, 9 and so on. The *svaras* in the respective octaves are therefore easily determined. The ratios 2, 4, 8 and 16 are all the commencement of higher octaves. The values of other notes in their respective octaves are $3/2$, $5/4$, $6/4$, $7/4$, $9/8$, $10/8$, $11/8$, $12/8$, $13/8$, $14/8$ and $15/8$. Reducing them and avoiding repeated ratios, we have $3/2$, $5/4$, $7/4$, $9/8$, $11/8$, $13/8$, and $15/8$.

We are already familiar with four of these seven ratios. Let us first consider only $7/4$, leaving out for the present $11/8$ and $13/8$.

When we strike a piano, at the key C we can easily hear when the note dies out, the *svara* *nī* ($7/4$) of the second higher (or next but one) octave. To my mind, it is at this pitch or frequency $7/4$, the voice can *catch* the Kaisiki nishāda, (flat *nī*) straight way, when the drone is being heard in the air, and *none other*.

Many of our melodies of the great composers start with the *nī* of the middle octave or lower octave thus,

(1) *jana ni ninu vinā* of Subbaraya Sastri in rāga Riti Gaula with notation as below, in seven units of time.

1	4 (Sa)		1	4	
ni	ni, Sa,	ni,		ga ri, Sa, ;	

The first ni is $7/4$ and the second ni is $9/5$.

(2) *Entharā* in Harikāmbodi of Thiagaraja in 8 units of time.

2		3		4		5
* * * ni	Da., ni	Sa,		, ni	Da ni	Sa, ni
e n	ta	ra		ni	ta	na

The first ni is certainly $7/4$.

(3) *Sarva Bhauma Saketa*.

3		4	
* * * ni	ni ni	Da	Da Da
sarva	bhau	ma	

5		7		8
Sa,,	Sa ni	Pa		Da Sa ni
sa	ke	ta		Ra ma

1 2
Pa Ma Pa
Ma na

The first ni is $7/4$ and the second also the same. The ni in | Śa ni Pa | is $9/5$.

The corresponding upper partial of Suddha Madhyama ($4/3$) has the frequency of $7/3$ or $7/6$ in the mid octave; the note ga $7/6$ is exactly in the same position on the Sa string

as ni $7/4$ is on the Pa string of the violin. To my mind, the ratio $16/9$ cannot be easily pronounced and I do get at it only by first saying Ma, then as Sa in that very pitch, and then saying Ma; from the latter pitch. It will then be seen that the note is higher than $7/4$ when actually tested.

GA

We have already considered svaras produced at various aliquot parts of the Sa and Pa strings namely $1/2$, $1/3$, $1/4$, $1/5$, $1/6$, and $2/5$. See Pages 8 and 9. On a Ma string, if we have it, we shall have the following relative frequencies $8/3$, or $2 \times 4/3$, 2, $16/9$, $5/3$, $8/5$, $10/9$ at the same aliquot parts, and we are already familiar with all these svaras. We may consider other aliquot parts, $1/7$, $1/8$, $1/9$, $1/10$, $1/16$, $1/21$, and $1/25$, parts damped from below.

		Sa string	Pa string	Ma string
		1	$3/2$	$4/3$
at	$1/7$	$7/6$	$7/4$	$14/9$
„	$1/8$	$8/7$	$12/7$...
„	$1/9$	$9/8$	$27/16$	$3/2$
„	$1/10$	$10/9$	$5/3$	$40/27$
„	$1/16$	$16/15$	$8/5$	$64/45$
„	$1/21$	$21/20$	$63/40$	$7/5$
		$(7/4 \div 5/3)$		$= (7/4 \div 5/4)$
„	$1/25$	$25/24$	$25/16$	$25/18$
			$= (5/4)^2$	

The notes formed on Sa and Pa strings at aliquot parts at $1/21$ and $1/25$ th from the head may now be considered. They are in the region between Sa and the Dvīśrnti rishaba ($16/15$), and Pa and Dvīśrnti Dhaivata ($8/5$), respectively. I have already noticed $7/6$ and $7/4$. And with $7/5$ the last two form a minor chord. $7/6$ is

exactly in the same position on Sa string as $7/4$ is on Pa string, and $7/5$ is in the Prati madhyama region.

Let us now consider how the voice can *most easily* produce certain svaras, which we can *prolong* straight without any quiver or grace, when the drone of the tambura is heard. The notes of the Sankarābharana rāga may be considered first.

Sa. We either say Sa direct or Śa (below), or again the voice may take up (lower) Śa, and come up to Sa ; or it takes (lower) Pa and goes to Sa in a gamaka (*See* page 43). It occasionally commences from Da ($5/3$) or ni ($7/4$) and stops at Śa; similarly for the lower octave.

If we want the chaturśruti Ri ($9/8$) the voice gets to the Pa of the drone and comes to Chaturśruti Ri, rising a Pa interval. Similarly Ga is (Sa) Ga; Ma is (Sa) Ma; Pa is (Sa) Pa. Da (Trisruti) can be produced either direct or better still, it is | Sa Da | ; and in actual play occasionally the Da is played on Pa string along with the Sa behind, of the violin.

Ni is really (Pa) Ni if one wants to produce the harmonic Ni; and higher Sa is (Pa) Śa or (Sa) Śa.

At this stage, I do not propose to deal with the other five (vikruti) changing Svaras *i.e.*, flats and sharps which can be so prolonged, and I shall do so later.

Rāgas are nowadays explained in South Indian Music by Sanchārakrama, *i.e.*, the order of ascending and descending notes (svaras). In Art music, the syllables, which

make up words of the songs have less importance, and the vowel sounds are more predominant, and the rise or fall in pitch is also apparent within the same vowel sound, which is prolonged. The instrumentalist, for record of the same immediately writes it down in each of his twelve *svaras*, to show how the rise or fall in pitch (or *svara*) occurs.

Gamakas, meaning 'movements', in South Indian Rāgas are generally described to fall into 12 types, as below.

(1) ĀROHA, Sa Ri Ga Ma Pa Da Ni Śa.

may be in threes, fours, fives etc., of the *svaras*, but in ascending order of pitch.

(2) AVAROHA, Śa Ni Da Pa Ma Ga Ri Sa also in threes fours or fives etc., of the *svaras* in descending order of pitch.

(3) DWANDA | Sa Sa | Ri Ri | Ga Ga | Ma Ma
(ĀROHA) and so on.

&

(AVAROHA) Śa Śa | Ni Ni | Da Da | Pa Pa and so on.

The items 2 and 3 may also be called 'Sphurita', emphasising a crushed note between the duplicated *svaras*, known also as *janta svaras*.

(4) TRIPUCCHA | Sa Sa Sa | Ri Ri Ri | and so on in threes of the same pitch.

(5) ĀHATA, | Sa Ri | Ri Ga | Ga Ma | Ma Pa | and so on, in ascent.

(6) PRATIĀHATA, | Śa Ni | Ni Da | Da Pa | Pa Ma |
and so on, in descent.

(7) KAMPITA really means shake as, when we say
ma (sharp), the voice generally drops from Pa;

(Sa) (Pa) (Sa)

(8) HUMBITA Pa Śa Ma

and other similar movements, passing through the whole
string, though no intermediate notes are separately heard.

The *svara* from which the music starts will be shown
above the line in brackets.

(9) ĀNDOLA, meaning a swing | Ma Ga | Sa Ni |
Ma ga | Sa ṇi | etc. The sound starting from the first
svara and ending with the second.

(10) 'ĀNDOLIKA' a word, I have coined, to mean a
shorter Āndola, that is a gamaka within the same *svara* as
defined by the ten svarasthānas or fret positions in the
octave, of the vina, except Sa and Pa.

(11) SPHURITA, | Sa, Ri Śa Sa | Ri, Ga Ri 1/2i | and
so on.

(12) LINAKA, prolonged or steady note.

These movements may be conceived in every Rāga,
according to its Āroha (ascent) and Avaroha (descent).

When we can imagine all these movements within *the*
Rāga, (with the peculiarity of *the* distinctive Ri Ga Ma Da
Ni giving its character) combined with an aesthetic sense

as to when these Gamakas are to be used, we get the elaborated Rāga Ālāpana. This remark also applies to Rāgas denominated janya rāgas, in which for instance, certain notes of the selected scale are dropped in ascent or descent, and to *Vakra Sampurna* rāgas.

Besides, there is the concept of Vādi and Sam-Vādi of the svaras of each rāga, (which the South Indian does not now define in his description of the Rāga, yet does realise it), namely, of what svaras of the Rāga are in the | Sa Pa | relationship, or in | Sa Ma | relationship to each other, which enrich the Gamakas.

Let any one try the Janta 'Varisai' (series) for *several Mela* Rāgas—see Chapter XI, and he will notice how a svara when repeated in each rāga changes slightly in character, against the *background* of the svara of the lower pitch (or fret) than the repeated svara in that scale.

| Sa Sa ri ri Ga Ga Ma Ma |

| ri ri Ga Ga Ma Ma Pa Pa | and so on, eight svaras in each till | Pa Pa da da Ni Ni Śa Śa |, both in ascent and descent.

It is under these Gamakas or movements, that quarter-tones as they are called, generally occur, and the twenty-two or more śrutis are felt by the ear. These movements can be illustrated. See the sentence.—

o ka Vana Cha ru da la nā du sa ho, da ra
Ri Ri Ri Ri Ri Ri Ri Ga Ma Ga Ri Ri Sa Sa, Sa, Ri Ga
etc. in *Nāmorāla gimpā* of Thiagaraja in Rāga Deva
Gāndhāri for āndolika gamaka.

The *svara* Chaturśruti Ri (or Suddha Ri in Hindustāni nomenclature) repeated six times, shows the Gamaka in Ri. *This Gamaka has a larger movement in range than the tremolo of the European music and is really from Trisruti to Chaturśruti Ri or even higher.* The Humbita Gamaka from lower Pa to Sa therein may be observed for the word 'ho' of the melody.

These śrutis may be said to arise also in another manner, namely, that in the technique of high music, the vocal chords easily step, *i.e.*, fall or rise by a *harmonic* interval of $6/5$ or $5/4$ or $4/3$ or $3/2$, *i.e.*, say a harmonic sādharana gāndhāra, harmonic Antara Gāndhāra, a Suddha Madhyama and a Pañchama interval, from harmonic notes that is, those formed at aliquot parts of a string or its simple nodal points.

Suppose we stop at Trisruti Da (frequency $5/3$ or $5/6$) the most important steady note of 'Kāmbodi' (besides Sa and Pa) which by the way is played occasionally for a sweet effect with the open Sa string, and if we want to pass a $4/3$ Suddha Ma interval, we reach $20/9$ or $10/9$ (Trisruti Ri), as in | Da Sa | Da ki, Sa | and not $9/8$ (Chaturśruti Ri concurring with Pa).

Similarly, from the *svara* 'Ma', a $4/3$ interval is $16/9$, and not $9/5$, the harmonic note on Pa string. If we want to drop from the *Svara* Ga $5/4$, a $6/5$ interval, we reach the note $25/24$ and not $16/15$. One can therefore notice that the correct delineation of the sweetness depends on the correct appreciation of the pitches of these notes, and of the intervals between them.

Again, say the prominent note in a Rāga is Chaturśruti Ri (Frequency $9/8$), as in Kalyāni, and we desire to pass up

a $3/2$ (Pañchama) interval, or drop a $4/3$ Suddha Ma interval, the note reached is $27/16$. Then it has to be produced, even when it is not a harmonic note, relative to Sa, but while in relation to Pa it is so, being $3/2 \times 9/8$. This generally appears as a grace movement from $5/3$; then it is pronounced generally Dha. See Phrase $\dot{R}i, . . . , | \dot{D}ha \dot{G}a \dot{R}i | \dot{S}a Ni Pa | \dot{D}ha Ni \dot{S}a \dot{R}i | \dot{S}a, . . . ,$ etc.

Notice also the following musical facts.

1. $2 \div 3/2 = 4/3$; a drop of a Pañchama from $\dot{S}a = Ma$ (Ma_1)
2. $2 \div 4/3 = 3/2$; a drop of Suddha Ma from $\dot{S}a = Pa$.
3. $2 \div 5/4 = 8/5$; a drop of a major third (Antar-gata Gāndhāra) from Sa give Dviśruti da (da_2)
4. $4/3 \div 5/4 = 16/15$; a drop of a major third (Antar-gata Gāndhāra) from Ma gives Dviśruti ri (ri_2)
5. $3/2 \div 5/4 = 6/5$; a drop of a major third from Pa gives Sādhārana gāndhāra (ga_2)
6. $2 \div 6/5 = 5/3$; a drop of a minor third (Sādhārana gāndhāra) from $\dot{S}a$ gives Triśruti Da (Da_1)
7. $4/3 \div 6/5 = 10/9$; a drop of a minor third (Sādhārana gāndhāra) from Ma gives Triśruti Ri (Ri_1)
8. $3/2 \div 6/5 = 5/4$; a drop of a minor third from Pa gives Antargata Gāndhāra (Ga_1)
9. $4/3 \times 6/5 = 8/5$; a rise of a minor third (Sādhārana gāndhāra) from Ma gives Dviśruti da (da_2)
10. $3/2 \times 6/5 = 9/5$; a rise of a minor third from Pa gives ni_2

11. $3/2 \times 5/4 = 15/8$; a rise of a major third from Pa gives Ni₁
12. $4/3 \times 5/4 = 5/3$; a rise of an Antargata Gāndhāra from Ma gives Da₁
13. $5/4 \div 6/5 = 25/24$; a *small semi-tone* above Sa
14. $5/4 \times 5/4 = 25/16$; that is a rise of an Antargata Gāndhāra from Antargata Gāndhāra gives a *small semi-tone* above Pañchama.
15. $(2 \times 6/5) \div 5/4 = 48/25$; a drop of an Antargata Gāndhāra from higher Sādhārana gāndhāra gives a *small semi-tone* flatter than (higher) Sa.
16. $8/5 \div 5/4 = 32/25$; a drop of Antargata Gāndhāra from Dviśruti dhaivata gives a *small semi-tone* flatter than Sudḍha Madhyama.
17. $7/4 \div 5/3 = 21/20$; also $7/6 \div 10/9 = 21/20$ a septimal Semi-tone.

Major Chords :

Coalescing notes when played simultaneously.

$$1. \quad 5/4, \quad 3/2 ; \left| \quad 4/3, \quad 5/3, \quad 2 ; \right| \quad 3/2, \quad 15/8, \quad 9/4 ; \left| \right|$$

Minor Chords :

$$1. \quad 6/5, \quad 3/2 ; \left| \quad 4/3, \quad 8/5, \quad 2 ; \right| \quad 3/2, \quad 9/5, \quad 9/4 ; \left| \right|$$

$$\left| \quad 5/4, \quad 3/2, \quad 15/8, \right| \quad 7/6, \quad 7/5, \quad 7/4 ; \left| \quad 10/9, \quad 4/3, \quad 5/3 \right|$$

Note added in 2nd Edition:—

For prolongation of one sub-unit of time, the vowel endings of the svara letters Sa, ri sometimes are denoted as | Saa | rii | and so on.

CHAPTER III.

RAGA : MĀYA MĀLAVA GAULA.

The reader may perhaps wonder why I have so far not treated of the Māya Mālava Gaula rāga, (mela 15) in which the first lessons in musical exercises are taught, and in whose *janya* rāga (Malahari for instance) the first *gitams* (by Perandara Dāsa, the Kannada musician) are even now taught in the Tamil land. The teaching of first lessons in this rāga presumably came into South India with this composer and saint. In the Sāma Veda chant we hear mainly the svaras of Kharaharapriya; even the śloka of the 2nd century B. C. Chatuh Chatuh Chatuh Chaiva, Shadja Madhyama Pañchamāh, Dve Dve Nishāda Gāndhārau, Tri Tri Rishabha Dhaivatan regarding the śrutis, could be understood only if it were interpreted with reference to the svaras of Kharaharapriya, or Bhairavi in ascent. In North India, the svaras of Sankarābharana (Bilāwal *thāt*) are called 'Suddha' and the first lessons there are in that rāga. So, as we came in late to teach Māya Mālava Gaula, I shall take it up now.

Māya Mālava Gaula (Hindustāni Rāga Bhairava)

Sa ri Ga Ma Pa da Ni Śa

Frequencies 1, 16/15, 5/4, 4/3, 3/2, 8/5, 15/8, 2

if we use svaras which are aliquot parts of Sa & Pa

Interval	16	75	16	9	16	75	16
between	—	—	—	—	—	—	—
svaras	15	64	15	8	15	64	15

Can we step this interval $75/64$, or would the svaras be thus ?

	Sa	ri	Ga	Ma	Pa	da	Ni	Śa
Frequencies	1, $25/24$, $5/4$,		$4/3$,	$3/2$, $25/16$,	$15/8$,		2	
	25	6	16	9	25	6	16	
Intervals	—	—	—	—	—	—	—	—
	24	5	15	8	24	5	15	

Should, or should not there be a musical interval between each svara as conceived by us, or would the svaras be,

	Sa	ri	Ga	Ma	Pa	da	Ni	Śa
Frequencies	1	$16/15$	$32/25$	$4/3$	$3/2$	$8/5$	$48/25$	2
	16	6	25	9	16	6	25	
Intervals	—	—	—	—	—	—	—	—
	15	5	24	8	15	5	24	

What the voice actually does in a fairly fast mood, as I judge musically, is that after reaching $16/15$ (*or even a lower note*), it raises itself to $4/3$, Ma, *i.e.* by a $5/4$ interval, and then drops a $25/24$ interval, and again goes to Ma. Ga is presumably therefore really Ma Ga ($4/3$, $32/25$) and Ni is similarly Śa Ni (2 , $48/25$). Thus the oscillation in the Ga and the Ni frets of the Vina in playing Ga Ma and Ni Sa may be understood. The violinist touches Ma itself before lifting his finger to Ga, which sits close to Ma in this raga.

Note added in 2nd edition. See Subbarama Dikshitar's Sangita Sampradaya Pradarsini, (1904); the nokku 'W' Sign, meaning 'press', is employed as a symbol for Ga & Ni in Māya mālava gaṇa exercises at page 15, in the Sangita beginner's book, Bala-Sikha (1905) for vina lessons.

Above Antargata Gāndhara ($5/4$), the voice does generally stand at two pitches one in gamaka and one 'linaka' between $5/4$ and $4/3$, cf, the (linaka) prolonged Ga of thoshamuga in song 'Tulasi Dala mula Che Santho-shamuga, of Thiagaraja. It is easy to see that this steady note Ga (the word of the melody is also Ga) is sharper than $5/4$.

Or again see Ga in Hamsadhwani varna | ja la ja | Ga, Ri, Sa,; | the first steady Ga is sharper than $5/4$ and I do not play this note with the Pa string behind, to produce consonance. What these frequencies are must be left for future consideration.

As already stated, the voice has to be fully opened for the note of frequency $5/4$, and Sa has to be remembered. It is easy to demonstrate $5/4$ as it will be in consonance with Pa string behind, as the violin is tuned in South India.

Again, so far as Ni is concerned, there is a similar sharp sound, Ni just close to Sa (in which the Hindustani music generally stands.) cf. also Ni in

1	2	3	4
xx ri Sa	Ni, Sa, ri	Ga ri Ga, : Ma, ..	
Me	ru sa	ma	na

of Thiagaraja in the same raga. The Ni of this raga here is certainly sharper than the harmonic Ni $15/8$. It is even sharper than the position to which Ni drops in Kalyāni, in Gamaka, from Sa. See charana of Adi Tala Varna of Kalyāni. Both do not reach Ni (harmonic) on the

violin. Ni, , , , (which is really Śa Ni—Śa Ni—Śa Ni) in gamaka of *ni luparani*.

| Ni, ; ; Śa Da | Śa Ni Da Pa ma Ga ma, | Pa, ; ;
| ni lu pa ra | ni

This probably distinguishes the 70 cent ($25/24$) interval in Maya Malava Gaula and the 90 cent interval below Śa of Kalyāni.

If we enunciate the law of musical intervals between successive svaras, we can see that in Maya Malava Gaula in the phrase Sa ri Ga ri Sa we should have the notes 1, $25/24$, $5/4$, $25/24$ and 1. Similarly for Pa da Ni da Pa we have $3/2$, $25/16$, $15/8$, $25/16$, and $3/2$. As a further illustration of the frequency ratios of $25/24$ and $25/16$, I may cite a small gitam in Gaula, which runs as follows.

Sa Ni Pa Ni Sa ri | ri Ma ri Sa Ni Sa
 $\frac{1}{2}$ of

1 $48/25$ $3/4$ $24/25$ 1 $25/24$ | $16/15$ $4/3$ $16/15$ 1 $24/25$ 1

(A) There is a definite gamaka of ri at $25/24$, and the voice stops there and picks up again at $16/15$ as there is a definite *step-up* as the melody goes up to Ma. You will find that in the violin Ni is always played as Sa Ni, and Ni is very sharp, (higher than in Kalyāni).

If we designate $25/24$ as $ri\frac{1}{2}$ and $25/16$ as $da\frac{1}{2}$ the use of these small semi-tones are found in the *Gitam* in Malahari.

1 2 3 1 (Pa)2 3
Ma Pa da_2 Śa Śa ri | $ri\frac{1}{2}$ Śa $da\frac{1}{2}$ Pa Ma
Pa | ri_2 Ma Pa da_2 Ma Pa | $da\frac{1}{2}$ Pa Ma Ga $ri\frac{1}{2}$ Sa
Sa, ri_2 Ma Ga $ri\frac{1}{2}$ | Sa $ri\frac{1}{2}$ Ga $ri\frac{1}{2}$ Sa etc.

CHAPTER IV.

CERTAIN OUDAVA (5 NOTE) RĀGAS.

In Chapter I, the changes from the Diatonic scale or Sankarābharana to six other melodies were considered with the change of Ādhāra śruti. Similarly, five small, but sweet rāgas, which are in vogue even in folk songs, may now be taken up. I refer to the rāgas Mohana, Madhyamāvathi, Suddha Sāveri, Suddha Dhanyāsi and Hindola (or Malnkos of Hindustani).

Let us start with the frequency ratios of 24, 27, 30, 36 and 48. It will be seen that the intervals between these notes which have frequencies of 1, $9/8$, $5/4$, $3/2$, $5/3$ and 2 are $9/8$, $10/9$, $6/5$, $10/9$ and $6/5$ respectively. We could easily see here that the octave is divided into one major tone, 2 minor tones and 2 minor thirds, ($9/8 \times 10/9 \times 6/5 \times 10/9 \times 6/5 = 2$). *Perhaps* by the variation of these five intervals to commence from Sa, five different rāgas have come into our music.

(1) Rāga Mohana.

	24,	27,	30,	36,	40,	48	
Svaras.	Sa	Ri	Ga	Pa	Da - Śa		both in Āroha & Avaroha.
Rel. Freq.	1,	$9/8$,	$5/4$,	$3/2$,	$5/3$,	2	
Intervals.	$9/8$	$10/9$	$6/5$	$10/9$	$6/5$		

But the symmetry on the Pa and Sa strings may require Ri to be $10/9$ (Ri_1) or Da to be $27/16$ (Da_2).

Svaras	1,	$10/9$,	$5/4$,	$3/2$,	$5/3$,	2	
	Sa	Ri_1	Ga	Pa	Da_1	Sa	
Intervals,	$10/9$	$9/8$	$6/5$	$10/9$	$6/5$		
or should the Svaras be with intervals		Sa	Ri_2	Ga_2	Pa	Da_2	Sa
		$9/8$	$9/8$	$32/27$	$9/8$	$32/27$	

What does the voice adopt? The Hindustani music lays stress on Da_1 in Bhoop. In South Indian music both Ri and Da and occasionally Ga are *oscillating* notes.

(2) *Rāga Madhyamāvathi*.

Svaras	27,	30,	36,	40,	48,	54
	1,	10/9,	4/3,	40/27*,	16/9,	2

*Here out of tune from true fifth; should be changed to be $3/2$.

	Sa	Ri	Ma	Pa(3/2)	ni_1	Śa
Intervals	10/9	6/5	9/8	32/27	9/8	

Would not the symmetry in ascent and descent require ni to be ni_2 or $9/5$: when the svaras would be 1, 10/9, 4/3, $3/2$, $9/5$, 2 and the intervals would be

10/9	6/5	9/8	6/5	10/9:
------	-----	-----	-----	-------

or should we change the music to be

	Sa	Ri_2	Ma	Pa	ni_2	Śa
with inter-	9/8	32/27	9/8	32/27	9/8	
vals.						

or should we have the svaras as

1,	10/9,	4/3,	$3/2$,	7/4,	2
----	-------	------	---------	------	---

(3) *Rāga Hindola (or Malnkos)*.

	30,	36,	40,	48,	54,	60
	1,	6/5,	4/3,	8/5,	9/5,	2
Svaras	Sa	ga_2	Ma	da_2	ni_2	Śa
Intervals	6/5	10/9	6/5	9/8	10/9	

Yet we occasionally reach da_2 from ni . What does this mean? Does ni_2 change to ni_1 (16/9) or $7/4$ on those occasions?

(4) *Rāga Suddhasāveri.*

	36,	40,	48,	54,	60,	72
	1,	10/9,	4/3,	3/2,	5/3,	2
Svaras	Sa	Ri ₁	Ma	Pa	Da ₁	Śa
Intervals	10/9	6/5	9/8	10/9	6/5	

or should the svaras be

	Sa	Ri ₂	Ma	Pa	Da ₂	Śa
	1,	9/8,	4/3,	3/2,	27/16,	2
Intervals	9/8	32/27	9/8	9/8	32/27	

Da₁ & Ma₁ are commonly in use in Hindustani, whereas in South India Ri and Da are both in oscillation, or in gamaka.

(5) *Rāga Suddha Dhanyāsi.*

	40,	48,	54,	60,	72,	80
Svaras	1,	6/5,	27/20*,	3/2,	9/5,	2

*Out of tune from fourth ; should be changed to 4/3.

	Sa	ga ₂	Ma	Pa	ni ₂	Śa
	1	6/5	4/3	3/2	9/5	2
Rel. Inter- vals then are	6/5	10/3	9/8	6/5	10/9	

Even from the above features noticed, we have to change the fourths or fifths in some cases to get a rāga concept ; much more so, can it be easily seen how the equal temperamental scale of the harmonium or the Piano *cannot* truly represent the melodic music, with *natural* intervals, even for such simple ragas.

CHAPTER V.

GENERAL CONSIDERATIONS.

Let us now consider the six important ragas which I noticed in the first chapter.

Karnātic Names.

- | | | |
|-------------------|----------|--|
| 1. Sankarābharana | Āroha. | Sa Ri Ga Ma Pa Da Ni Śa |
| | Avaroha. | Śa Ni Da Pa Ma Ga Ri Sa |
| 2. Kāmbodhi | Āroha. | Sa Ri Ga Ma Pa Da Śa |
| | Avaroha. | Śa ni Da Pa Ma Ga Ri Sa
(ni is absent in Āroha). |
| 3. Bhairavi | Āroha. | Sa ga Ri ga Ma Pa Da ni Śa |
| | Avaroha. | Śa ni da Pa Ma ga Ri Sa
(the phrases Sa Ri ga Ma
and Pa da ni da are per
missible in ascent). |
| 4. Kalyāni | Āroha. | Sa Ri Ga ma Pa Da Ni Śa |
| | Avaroha. | Śa Ni Da Pa ma Ga Ri Sa |
| 5. Kharaharapriya | Āroha. | Sa Ri ga Ma Pa Da ni Śa |
| | Avaroha. | Śa ni Da Pa Ma ga Ri Sa |
| 6. Thodi | Āroha. | Sa ri ga Ma Pa da ni Śa |
| | Avaroha. | Śa ni da Pa Ma ga ri Sa
(occasionally Pa is omitted in
ascent and descent also). |

I. Compare Sankarābharana and Kalyāni. In the former there is Ma and in the latter ma, which are the only

distinguishing features between the two ragas in *common parlance*. Yet we distinguish the ragas and differentiate them, even though Madhyama, Suddha or Prati, are respectively omitted in the raga for some small interval of time.

Consider the phrases in Sankarābharana and in Kalyāni.

<i>Time</i>	1	2	3	4	5		
1. Sankarābharana	Śa Rī	Ni Śa	Dha Ni Śa	Pa Dha			
		6	7	8			
			Ni Śa	Da Pa	(Ma Pa Da)		
	1	2	3	4	5	6	7
2. Kalyāni	Śa Rī,	Ni Śa Ni	Dha Ni,	Śa Ni Da Pa			
					8		
						(ma Ga Ri)	

Before even arriving at the last phrase in brackets above, we can recognise the ragas as different. How do we do so? The ear is certainly not deceived. That there is a physical counterpart, we should naturally imagine. The concept of *srutis*, micro-tonal changes, has therefore to be brought in, for our better understanding of the raga *bhava* of the two ragas in question. (The difference is even in the first Rī, also in the Ni's.)

Or even, consider the following phrases (in Kalyāni) which are played with a single bow for each *svara*.

Rī, . . . , | Dha Ga Rī | Śa Ni Pa | Dha Ni Śa Rī |
 Śa, . . . , etc., or | Dha Ni Śa Rī | Ga Rī Śa Ni Da Pa, (ma
 Ga Ri).

We also see that they are both in Kalyani, but not in Sankarābharana.

*Note :—*I have put in Dha, when in svara singing Da is stressed with an aspirate.

By carefully observing our fingers on the violin and fingering technique on the Vina too, we can come to the conclusion that the ear perceives this difference of the raga bhava, because the Ga and Ni are generally slightly sharper in Kalyāni than in Sankarābharana.

Now-a-days some sing Kalyāni raga, of course in their Alāpana, (improvisation) as if it were the Sankarābharana raga with the Pañchama svara as the ādhara sruti itself or the fundamental. At least, my ear feels that their singing conveys the bhava of Sankarābharana. This method in my opinion is quite wrong. The svaras of the Kalyāni in this *change* of the mode do compare *roughly* with the notes of the Kalyāni in the Sa scale, but they do not convey the Kalyāni *bhāva*. What happens in their attempt is that the original Ni of the Sa scale is slightly lowered, and we feel it as Ga in the Pa scale, (the harmonic note of the major third in relation to Pa). Similarly also, there is a very small flattening in the pratimadhyama of the original Sa scale, and it is felt as Ni in the Pa scale, the harmonic note or $15/8$ ratio thereof. These mistakes in the change of model set before us (as for instance, in the Aṭatāla varṇa 'Vanajākshi', in Kalyāni) should *not* be allowed. The sruti concept alone, besides certain other features which I shall dilate upon later, must prevent such a medley or the confusion of rāga bhāva.

II. Compare again, for instance, Kāmbodi and Sankar-ābharana so far as the svaras Sa Ri Ga Ma Pa Da are concerned. They are stated to be the same. The Ni Kakali, or ni Kaishiki, is the only difference in them and yet consider these phrases.

Sankar- 1. Sa, , Ri | Ga, , Ma | Pa, | Pa Ma Ma, Ga |
ābharana Ma, Pa, | Da, , Pa.

2. Sa Pa, | Pa Ma Ga, Ma Ri Ga, | Ma Pa,

Kāmbodi. Ri, , | Pa Ma Ga, | Ma Ga Ri, Ga | Ri Sa Sa,
Pa, the vertical lines denote the run of the phrases.

One does feel the rāgas quoted, though the specific nishāda does not appear.

Further, you will notice that unaspirated svara Da is elongated *straight* to six matras of time in Kāmbodi raga as in the following example of the varna in Adi tāla (Taruni).

Da , , , , , ni Pa Da ni ni Da Ma, Pa Da etc., or the elongated word Ra in the phrase Bhakta Parādhi in the charana of Tyagaraja's Kriti Evarimāta in Kāmbodi, whereas the svara Da is always, more or less, found as oscillating note, whenever elongated in Sankarābharana.

III. Again, there is a lot of mixing of the raga bhāva in the Kharaharapriya and of Bhairavi; because of the *accidental* Da (as in Da ni Sa or Da ni Sa Ri etc.) which occurs in the latter. True, the phrase Sa Ri ga Ma is permitted in Bhairavi, but if properly played we need exhibit Bhairavi only, in the phrase | Da ni Sa Ri ga Ma

Pa | so that Kharabharapriya bhāva is not at all felt, though under the system of 12 frets the notes are said to be the same. Wherein lies the difference in Bhāva? Again, without a concept of srutis, one cannot offer a physical explanation.

Or again, take Thodi (Karnātic), the svaras ga Ma Pa da ni are alleged to be the same as in Bhairavi; yet we manipulate them differently and we do feel that they are not identical in *bhāva*. I shall mention in a following chapter my present conclusions as to the various srutis, which are characteristic of the ragas, as judged by the ear, and to some extent, from the technique of play on the violin or the vina.

From the table summarising all the ratios, which are formed by aliquot parts of strings in the gamut of our melody, we find that there are at least three or four possibilities round about the *ten* frets of the vina in the octave (except of course Sa and Pa which are fixed for the melody.)

From my lessons for over three years from Mr. Purohit, a pupil of the late Pandit Vishnu Digambar, who, by the way, has done so much for the revival of Hindustani music in the Maharāshtra and in the Punjāb, I learnt that his classification *for all practical purposes* of Hindustāni music, as he had taught and written down in his books for the elucidation of his students, is, as follows.

Besides Shadja, Panchama and Suddha Madhyama, he has described three Rishabas, three Gāndhāras, three Tivra

THE TWELVE SVARAS.

Calculated	Sa	ri	Ri	ga	Ga	Ma	ma	Pa	da	Da	ni	Ni	Sa
Strutis on	236/243	10/9	<u>10/9</u>	32/27	5/4	4/3	45/32	3/2	128/81	5/3	16/9 =	15/8	2
Sa Ma and	-90 cents.		<u> </u>	, <u> </u> ,	<u> </u> ,	<u> </u> ,	<u> </u> ,	<u> </u> ,	<u> </u> ,	<u> </u> ,	(4/3) ² ,	<u> </u> ,	
Sa Pa bases	16/15	9/8 =	<u>9/8</u>	6/5	81/64	27/20	64/45	8/5	27/16	9/5	243/218		
in order	(112 cents.)	<u>1/2</u> of	<u> </u>										
of ascent.		(3/2) ²											

The underlined ratios are those obtained on aliquot parts of Sa and Pa strings or their nodes.

25/24 or 70 cents *above* = 70 cents.
 Sa, Ma & Pa respectively.

25/24 or 70 cents *below*
 Ma Pa and Sa; Total 6.

On the basis of the seventh harmonic.
 Total 4.

$$25/18 \quad 25/16 = \frac{(5/4)^2}{(5/4)^2}$$

$$32/25 \quad 36/25 = (6/5)^2$$

$$48/25$$

$$\begin{aligned} &21/20 \quad 7/6 = 267 \text{ cents.} \\ &(7/6 \div 10/9) = 85 \text{ cents.} \quad 8/7 = 4/3 \div 7/6 \quad 9/7 \\ &\text{or} \quad = 231 \text{ cents} \\ &7/4 \div 5/3 \end{aligned}$$

$$7/5 = 583 \text{ cents.}$$

$$7/4 = 969 \text{ cents.}$$

$$12/7 = 2 \div 7/6$$

Madhyamas, three Dhaivatas and three Nishādas, making in all 18, which are as under.

Shadja

1. Atikomāl		
2. Komāl		Rishaba
3. Suddha		

1. Atikomāl		
2. Komāl		Gāndhāra
3. Suddha		

Pañchama

1. Atikomāl		
2. Komāl		Dhaivata
3. Suddha		

1. Atikomāl		
2. Komāl		Nishāda
3. Suddha		

Suddha Madhyama

1. Tivra		
2. Tivra tara		Madhyama
3. Tivra tama		

Tāra Shadja (Octave)

He has also made mention of one *Ati-Ati- Komāl* Rishaba in Puriya Raga, that is to say in all 19 notes. He has suggested to the student the desirability of his appreciating these microtonal changes, and gives at the head of every raga in which the melody is composed, the particular notes, which according to his classification, enter into the composition. We may denominate these ratios as,

Sa ri_1^b ri_1 ri_2 ga_1 ga_2 Ga Ma ma_1^b
 ma ma_2 Pa da_1^b da_1 da_2 ni_1 ni_2 Ni Śa

Since the Suddha notes are the Bilawal That, (the same as the Sankarābharana mela) we find in his description of Bhairavi, corresponding to Hanumathodi of the South Indian scale, that it takes the following svaras :—

Sa ri_1^b ga_2 Ma Pa da_1^b ni_1 and Śa

We can ask ourselves the question "Is it possible that the Hindustani musician does *not* realise the possibilities of the variation of *srutis* selected for the particular raga within the Komal (flat) svaras here? Will not the voice attempt a compromise of slightly varying them; and are there not other possibilities of the same Komal svaras arising for instance in Hindustani Bhairavi (or Hanumathodi of South India)? Will not the voice rise on *any* occasion to ri_1 , ga_2 or da_1 or ni_2 ?

The accidental notes, which the Hindustani musician introduces for a variation in a raga come up to one of the *higher* frets as denominated by the twelve frets of the octave, as the South Indian often notices in his ragas; the South Indian to my mind however, refuses to change the svaras in his ragas, but introduces only the microtonal changes round about the frets, which can be denominated in 5 vikriti svaras of the selected frets. Is it on this account that the South Indian does not feel in Karnātic music the monotony which he feels in listening to Hindustani music, though he appreciates it, as it is sweet enough for his ear?

After describing the five European modes on the white keys, starting with C, G, D, A and E that correspond to 1. Sankarābharana, 2. Harikāmbodi, 3. Karabharapriya, 4. Nata Bhairavi, 5. Hanumathodi and the changes they have made in the Nata Bhairavi by introducing in the ascent, the raga Gauri Manohari and in the descent the raga Kiravāni, Mr. Fox Strangways, a great student of Hindustani music, in his article on "Music" in "Legacy of India" already quoted above, goes on to say that in Hindustani (Northern Music) any note (except the svaras Sa and Pa)

is subject to enharmonic treatment and he describes the raga as a chosen path of seven notes among the 22 srutis, the Panchama being never altered, though it may be omitted. And he further avers that the Hindustani musician thinks that by the mere change of A or Dhaivata to Trisruti or Chatusruti their Bilawal and the Bihag vary. I do not think the South Indian considers that in the same raga the (second) twin (note) sruti of a particular svara should not at all come in. It is only the way in which the twin note appears which makes all the difference.

The orthodox South Indian tradition about the use of the srutis is that the srutis are considered as twin notes, as far as possible, and that *in the ascent, (āroha) the higher sruti of the selected svara is used, and in the descent (avaroha) the lower śruti of the selected svara is used*. That is why even in the vina frets, as I have already said, the *lower* of the twin notes (except for ri and da) have been fixed, as the higher sruti on the vina can be got by the mere deflection of the string across the fret. Of course, there are a few exceptions to this rule, as far as the two or three prominent notes (besides Sa and Pa) which were defined in the past as the Amśa*, Graha and Nyasa notes are concerned. It must also be realized that in South India we close with either the Shadja or the Panchama, while in the north, in Hindustani Music, they do not do so, and they may rest at any note chosen, preferably the first note or of the first phrase of the song. That really makes an important difference in the effect of the raga on the ear.

*Amsa means important ; Nyasa means ending note of a phrase; Graha is the first note of a raga.

CHAPTER VI.

REPLIES TO QUESTIONS IN CHAPTER II.

I was able to obtain a brand new set of eight tuning forks of Becker & Co., of the Diatonic Scale, \dot{C} to C for a musical judgment of the 19 various ratios described in the first chapter, ^{and} obtained mathematically by change of the fundamental. The results of a careful study of the six ragas got by the change of the fundamental are enumerated below. They can be verified by any student of music, who has a fine ear. I could make no temperature corrections, but the major scale as | Sa Ga Pa | | Ma Da \dot{Sa} | and Pa Ni Ri | was true.

1. *C. Scale*, Fig. 1, Page 11.

It is easy enough to notice that the tuning forks D and A are not in Sa-Pa relationship. That is to say, Ri and Da are respectively Ri_2 (Chatusruti) and Da_1 (Trisruti) from Sa and Pa respectively.

2. *Scale commencing from D tuning fork.* Fig. 2, Page 12.

The first ratio is 10/9. Singing the Kharaharpriya with D as fundamental, it is found that the tuning fork E gives a pitch less than Ma in Rama of the song Rama Neeyada. The melody here starts with (Pa) Sa (Pa) Ri i.e., with the background of Pa. The Ri is there Ri_2 (9/8). But the tuning fork tallies only with the sound 'bo' in Viribo in the *Viriboni* varna of Bhairavi of South India, starting with the notation | \dot{ni} . Sa, Ri, | because the Ri here (of Bhairavi) is Trisruti or Ri_1 .

The tuning fork F giving the next ratio $32/27$, gives a higher pitch than the ga used in Bhairavi rāga in the phrase Sa ga, Ri ga Ma, Pa. The ga in Bhairavi (which is realized as ga_1) is not $32/27$ and the probability is $7/6$.

The tuning fork C, having a ratio of $16/9$ from D is found higher than the ni in Surati raga prolonged in descent as in | Sa ni ni, Da Pa. | Hence the surati ni is not $16/9$, and is probably $7/4$ when prolonged. Taking *Ma* of the violin string (tuned D) as shadja and by going up a Ma (exactly singing it) we reach $16/9$. This is not, however, even the lower ni by the voice.

The tuning fork A with interval $40/27$ from D is found less than Pañchama, and cannot be identified with any svra. The tuning fork B is Triśruti Da (Da_1) in the scale.

3. *Scale from E (tuning fork)* Fig. 3, Page 13 with the ādhara śruti taken as E for the music; it is found that $16/15$ (tuning fork F) and $8/5$ (tuning fork C) are felt sharper than the generally used ri and da of Hanumathodi in the Aṭa Tala Varna. The one instance known to me of the prolonged, linaka 'ri' namely in Puṇnāga Varāli (janya in Hanumathodi) in the phrase *Ka na ka cai la vi ha* with notation** ga Ma ga, ; ri, ; Sa, ri ni Sa

Ka na ka cai la vi ha

(2nd ga in Gamaka from Ri_1)

is also found flatter than $16/15$. The frets *ri* and *da* on the Sa string of the Vina examined, which are used much for Maya Malava Gaula also are actually flatter than $16/15$ and $8/5$.

In the charana of Viriboni varna in Bhairavi,
da, ni ni da da, ni da da Ma

the first elongated da is flatter than $8/5$ while the second elongated da is found to be $8/5$, (Tuning fork C).

The frequencies $6/5$ (tuning fork G) and $9/5$ (tuning fork D) are found to be the ga and ni in Ritigaula in the phrases in singing ga ga, and ni ni, (the second prolonged svaras). Frequency $8/5$ (tuning fork C̣) is even sharper than the steady notes 3rd and 4th da, found in Kanakangi-Mela Raga Malika in the phrase, 'Sanakādi priya'-starting with the notation da da (Pa) da, (Pa) da,

sa na Ka di

4. Scale from F Tuning fork Fig 4, Page 13.

The music being started with F as the ādhara śruti, the ratio $9/8$ (tuning fork G) tallies with the word Te in Kaligiyunte of the song in raga Kiravāni : the notation being

(sa)
,, Ri Ni, Sa Ri, Ri, ; ; ga Ri
Ka li gi yum te ga

The ratio $5/4$ (tuning fork A) is found less than the Ga generally used in Kalyāni in ascent, and it is only the harmonic Ga used in Sankarābharana. In Dikshitar's song in the charana of his Kamalāmbām Bhajare, in the words

Nityakalyāni Sa, Ga, Ri, Ni, , Ri Ga, Sa both Ga's tallied.
Ni tya Ka ly a ni

and here Ri becomes Ri₁.

The ratio $45/32$ (tuning fork B) is either too sharp for the descending note ma in Kalyāni as in Pa ma Ga Ri, and too flat for the ascending note as (Pa) ma Pa.

Regarding the ratio $27/16$ (tuning fork D) we find the voice stopped at that frequency in the words *thandri* in Kanna thandri - of the charana of the song.

Pa Pa Da, Da,

Ennāduni in Vāchaspati Rāga (Sa Ri Ga ma Pa Da ni Sa) of Patnam Subrahmanya Iyer.

The ratio $15/8$ is less than Ni in *Nilupa Rani* in charana of the Adi Tala Varna in Kalyāni.

From these facts we can see for ourselves how much the Kalyāni scale has differed from the Kalyāni of the Aṭa Tala Varna in rāga Kalyāni.

5. Scale from G. Fig. 5, Page 13.

When Kāmbodi is sung with G as ādhara śruti, the ratio $16/9$ (tuning fork F) is found sharper than the svara ni we actually use in | Da, ni Pa Da ni ni Da | Ma, Pa etc.

6. Scale starting with the tuning fork A Fig. 6, Page 14.

Starting the music with the ādhara śruti A, it is found that all the notes given, though stated to be Nata Bhairavi, are sharper than the Bhairavi of South India. One observation may be made here that in the musical experience of myself and others who helped me in this investigation, we *never* find in South Indian Music the svara $16/15$, and $8/5$ elongated straight at all for any large *interval of time*. In Pharaz, as defined by Syama Sastri, a Janya rāga in Māya Mālava Gauḷa where the Pañchama is 'varjya' or absent

the flat Dhaivata stands at $8/5$! It is probably also the case in South Indian Hindola, or Malnkos of the Hindustāni musician.

Here also, in the charana of Viriboni already quoted page 66—(against the scale of tuning fork E) the first prolonged da is flatter than $8/5$ and the second prolonged da is $8/5$, (Tuning fork F).

The ratio of $27/20$, that is, the tuning fork D, is found *flatter* than Madhyama, though it is in gamaka in the phrase Da Pa Ma, Ga Ri Sa, in the Begada varna.

7. *Scale commencing with the tuning fork B* Fig. 7, Page 14.

Our search for the Prati madhyama equal to $64/45$ in any raga proved futile. In the kritis, in rāgas using Prati madhyama it always descends from Pa. There is an Andola Gamaka from Pa to ma and back to Pa, and it is very difficult to distinguish the note $64/45$ as used in any of our rāgas.

CHAPTER VII.

PROPOSED THEORY OF KARNĀTIC MUSIC.

Before I state my general conclusions, I should like to make certain simple observations. To my knowledge, the frequency ratios at which the voice can stop and straightly prolong them *i.e.*, in 'linaka' notes as observed by me in musical compositions in Karnātic music, and in my own musical experience, are the following ratios:—

1, $16/15$, $10/9$, $9/8$, $7/6$ (septimal third), $6/5$, $5/4$, $4/3$, $7/5$, $3/2$, $8/5$ to a small extent, $5/3$, $7/4$ (septimal seventh), $9/5$, $15/8$ to a small extent, and 2. (These ratios are obtained

by damping aliquot parts of Sa and Pa strings or from their simple nodal points.)

A few examples are given below.

During the course of the investigations themselves I have to a large extent stated where these fifteen ratios are and have exemplified them already. I may state that $7/6$ (ga) is specially noticeable in Ananda Bhairavi in the phrase Ri Ma ga Ri Sa. $7/5$ (ma) is particularly noticeable in Ramapriya in the phrase Pa Da ni Da Pa ma. At that point ma, I feel a resonance with upper partials. When I bow the string by lightly touching it, I hear the upper partial 7, the Surati nishāda; $7/5$ has a relationship of an Antargata Gāndhāra interval of $5/4$ behind $7/4$. ($7/4 \div 5/4 = 7/5$). $8/5$ (da) is pronounceable only when the pañchama is (varjya) absent and the voice steps directly a *minor* third, from Ma₁ as in Pharaz of South India. The names which may be given to these notes are

Ratios.	Svaras.	Remarks where the prolongable notes occur.
1	Shadja.	Fundamental
$16/15$	Dviśruti ri	In Malahari
$10/9$	Triśruti Ri	In Durbār and Madhyamā- vati when ga is absent.
$9/8$	Chatuśruti Ri	In Kharaharapriya.
"	"	A gap here.
$7/6$	Madhya gāndhāra (Seventh upper partial of Madh- yama)	In Bhairavi and Ānanda Bhairavi. (Septimal minor third.)

6/5	Sādhārana gāndhāra	In Ritigaula when prolonged.
5/4	Antargata Gāndhāra	In Yadukula Kāmbodi especially.
„	„	A gap here.
4/3	Suddha Madhyama	the true fourth.
„	„	A gap here.
7/5	Prati madhyama	In Rāmapriya.
3/2	Pañchama	the true fifth.
8/5	Dviśruti dhaivata	In Pharaz
5/3	Triśruti Dhaivata	In Kāmbodi
7/4	(Septimal) ni-7th upper partial of Sa	In Surati
9/5	Kaisiki nishāda	In Ritigaula, when prolonged
15/8	Kakali Nishāda	In Sankarābharana

Even the order of the above ratios suggests that

- (1) between 9/8 and 7/6 there can be 8/7
- (2) between 5/4 and 4/3 we can have 9/7
- (3) between 4/3 and 7/5 we can have 11/8, the eleventh upper partial of Sa.

Whether the ratios 8/7, 9/7 and 11/8 may not figure in our music at all, is a question which any investigator should consider; but I have not been able to verify the same for want of facilities.

N.B.—(1) The ratio of 9/5 to 7/4 is 36/35 *i.e.* of a harmonic minor seventh to the septimal minor seventh.

(2) (a) The ratio of 6/5 to 7/6 is 36/35 *i.e.* of a harmonic minor third to septimal minor third.

(2) (b) The ratio of 12/7 to 5/3 is 36/35

(c) Do. 8/7 to 10/9 is 36/35

(3) Do. 11/8 to 4/3 is 33/32

Note added in 2nd edition. The frequency of $12/7$ is on the same position on the Pa string as $8/7$ is on the Sa string. The use of the quarter tone ($36/35$) in music has since been verified in gamaka from $5/3$ & $10/9$ respectively, *vide* appendix.

There is, however, a 'linaka' Ga lying between $5/4$ and $4/3$; and a 'linaka' Ni between $15/8$ and 2 at which the voice easily stands. I have already given illustrations from musical compositions. To add another illustration, take | Ma, Ga, Sa, ni, Da; ni, Sa, | in Natakurunji. The Ga seems to my ear sharper than $5/4$. The Ga may be a ratio of $9/7$ from Sa and a similar interval from Pa may exist; but I have no means of verifying them. I do not play the Ga with the Pa string behind on the violin.

Then there is a further problem, whether, when the voice reaches these 'harmonic' notes direct, the adjacent note, when descending or ascending, is a semi tone or a small semi tone or a quarter tone from the former. We have noticed two ratios in the course of investigation of less than a semi tone of $16/15$, namely $25/24$ and $21/20$. The ratio $25/16$ is the position on the Pa string above Pa when you pass a $5/4$ interval from the $5/4$ or Antargata Gāndhāra. The ratio $21/20$ is the ratio of $7/4$ to $5/3$ i.e., from the harmonic septimal ni to Trīśruti Da. At both these ratios of $7/4$ and $5/3$ the voice can stand steadily.

It is very probable that from $Ri_1(10/3)$ and from $Da_1(5/3)$ such a small interval of $21/20$ is pronounced and then the respective frequencies so produced, $7/6$ and $7/4$, respectively reached are harmonic and prolongable notes.

A general observation as regards South Indian music.

i. Take Sankarābharana for instance. We do not produce svaras if we want to say them as Sa Ri Ga Ma Pa Da Ni as described in the *second* chapter, page 41. If we just want to sing them in a slow tempo, we say Sa Ga Ri Ga the word Ga Ri being repeated even twice *very fastly* to represent the Ri. Ma is produced as | Pa Ma | and Da is produced as | Ni Da | exactly like Ri from Ga in the ascent.

ii. Take for instance, Bhairavi. When we want to say ga after Ri₁ the voice generally comes down from Ma and it ought to be so, though it is just a slight touch. Probably as the gamaka, the voice reaches $7/6$ straight as a harmonic note (it being an upper partial of $4/3$) from Ma and as I have already said, the ratio $10/9$ or Ri₁ is itself got by inversion from Ma, that is a dropping of minor third from Ma.

iii. Or take Hanumathodi for instance; after voicing da, if we want to say ni, the voice on many occasions goes up to Sa and drops to ni.

iv. Take for instance, Karaharapriya or Harikāmbodi. If after standing at Da, we want to produce ni, it goes up to Sa and drops sometimes to a larger extent and sometimes to a smaller extent. I should imagine therefore that the drop is not by a minor tone and a major tone, but rather to the harmonic notes themselves of $9/5$ or $7/4$.

From these illustrations, we can very well see that the voice in South Indian music reaches from the 'harmonic' notes a longer interval, such as a minor third in some cases or more, and forms a certain loop before coming down to a lower note, that is to say, the notes work themselves into patterns of loops, and the several svaras are

not quite discontinuous and separate as played in the piano, but quite continuous. The importance of the Andolka and Kampita Gamakas between svaras is thus emphasised in South Indian music, and it is this characteristic of Vina play, which has been impressed on Karnātic vocal music.

Even as the present vina fretting goes, there are only three frets, not formed by simple aliquot parts, such as $16/9$, $45/32$ and $32/27$, while others are 'harmonic' ratios.

Talking of Vina play, I may say, the more advanced the artist is, the more does he play mostly from the Sankarābharana frets, producing the flats and sharps; The Sankarābharana varying from the Diatonic scale, only in the matter of Ri, the South Indian uses $10/9$ instead of $9/8$. We can therefore certainly imagine that these quarter tones are produced from the svaras, where the voice does stand and can stand easily.

CONCLUSIONS.

As for every fundamental pitch of a singer, the listener is able to say that music is true in every rāga which the artist sings or plays, I believe the part of the ear (which appreciates the music and is alike a piano with about 20,000 strings all compressed in a small compass) adjusts itself to *harmonic* notes arising from such Sa and Pa of the drone.

Having found five at least of these *complex* ratios namely $32/27$, $16/9$, $27/20$, $45/32$, $64/45$, and $40/27$ on the Sa Pa and Sa Ma bases, *absent generally in our music i.e. not present as prolonged Svaras*, I presume we have to discard, if not entirely, the evaluation in our music of to-day, of the śrutis on the Sa Pa and Sa Ma bases.

Consider the possibilities of the 13 frequencies from Sa to Pa being as follows, forming simple harmonic ratios, and forming a series from 10/9 to 5/4.

1. Ekaśruti rishabLa	25/24 or 21/20, both in Gamaka or as short svaras
2. Dviśruti rishabha	16/15 (rarely used in prolongation)
3. Triśruti Rishaba	10/9
4. Chaturśruti Rishaba	9/8
@ * * * *	$8/7 = 4/3 \div 7/6 \uparrow$
5. Madhya gāndhāra	7/6
6. Sādbārana gāndhāra	6/5
7. Antargata Gāndhāra	5/4
@ 8. Tivra Gāndhāra	$9/7^* = 3/2 \div 7/6 \uparrow$
9. Suddha Madhyama	4/3
@ 10. Tivra Madhyama	11/8
11. Prati madhyama	7/5
@ 12. Tivratara madhyama	$10/7 = 3/2 \div 21/20$
13. Pañchama	3/2

*As a probable illustration of the Tivra Gāndhāra 9/7 I might draw the attention of the reader to the song of Thiagaraja in Sahāna beginning with the words *eevasudha* the notation being Ri, Ga Ma Pa. The Ri starts from very much above Ga (5/4) on the Sa string of violin, and the next Ga is particularly sharp though short but definite and not oscillating. This is a very Tivra Ga in music that I have noticed, in suddha Madhyama rāgas.

@ † See next page.

I have already stated that there is 'linaka' Ga between 5/4 and 4/3 which is most easy for the human voice. Venkatamakhi, the author of "Chaturdandi Prakāśika", the principal treatise followed by modern Karnātic

musicians says that this is a śruti below Suddha Madhyama, and he calls this Antara Gāndhāra. That is the reason why I have denominated $5/4$ as *Antar gata* Gāndhāra to avoid confusion. It is suprising therefore that Mr. Clements at page 43 of his book, “Rāgas of Tanjore” (London, 1920) makes the statement “The author for some unknown reason makes things worse by putting Antara and Kakali only one śruti below Ma and Sa”. I have already given examples where such a lnaka note above $5/4$ and below $4/3$ occurs in our compositions.

We can also enunciate similar positions from Pa up to its Suddha Madhyama position or higher Shadja.

14. Ekaśruti dhaivata	$14/3^*$ or $25/16$ or $63/40$
15. Dviśruti dhaivata	$8/5$
16. Triśruti Dhaivata	$5/3$
17. Chatuśruti Dhavita	$27/16$
@ * * * *	$12/7 = 2 \div 7/6 \dagger$
18. Madhya nishāda	$7/4$
19. Kaisiki nishāda	$9/5$
@ * * * *	$11/6$ see below.
20. Kakali Nishāda	$15/8$
21. Tivra Nishāda	$48/25$ or $40/21$ in gamaka
22. Shadja	2

* $14/9$ is a $7/6$ interval from $4/3$ just as $8/5$ is a $6/5$ interval from $4/3$.

@ Not verifiable with my present facilities.

† Note added in the 2nd edition :—

As stated in the Appendix to this edition, the svaras in gamaka movements are capable of being derived by inversions also of a septimal minor third ($7/6$) from Ma, Pa and Sa. The plausible examples are—ga from Ma in Atāna; Ga from Pa in Hamsadhvani; Da from Sa in Vasanta.

One may recollect the hot discussion in the Music Academy, Madras in recent years about Nishāda and Madhyama used in Rāga Begada, which are characteristic of the rāga. Some said that it was Kaisiki Nishāda and others held the opinion that it was Kakali Nishādā. In my own mind, I feel it sharper than the Nishāda of Ritigaula of $9/5$, but flatter than the Kākali Nishāda, the harmonic $15/8$, and the drop in gamaka in this case is not a minor tone from Sa to ni_2 , but something less in extent.

One could also perceive that the drop from the Pañchama to the Madhyama of that rāga is equal in extent to that from higher Shadja to Nishāda. The ratio $3/2$ to $11/8$, (the latter being an upper partial of Sa) is equal to the ratio of 2 to $11/6$, the Begada Nishāda, the latter being an exact Madhyama ratio from $11/8$. The drop would be $12/11$ instead of $10/9$.

Mr. Clements in his book "Rāgas of Tanjore" has only 18 notes or svaras in use in South India and he styles them as follows, practically following what the late Vishnu Digambar has stated for his Maharāsthra-cum-Hindustāni music. He has Sa, four Ri's, three Ga's, Suddha Madhyama, Prati madhyama, Pañchama, four Da's and three Ni's. He uses the word "mridu" for the first Rishaba and the first Dhaivata, above Sa and Pa respectively. He denominates mridu rishaba as a ratio $21/20$ from Sa as detected by his harmonical! He also considers that we use the ratio $32/27$ as 'five śrutis'; but my tests with the tuning forks show that the lower note of the "Sādhārana gāndhāra" or ga_1 is not $32/27$.

He has not anywhere stated that we are using the note $7/4$ at all in South Indian music. Nor has he noticed that the ratio $21/20$ is that of $7/4$ to $5/3$.

It is perhaps necessary for me to point out the difference between the above selected ratios and the notes which have been obtained either on the Sa—Pa and Sa—Ma bases, which I reject, and the notes which are just 70 cents or $25/24$ above and below Sa Ma and Pa.

The ratio of $7/6$ to $32/27$ is 189 to 192, a diffce. of 27 cents

„	$9/7$	„	$81/64$	„	576	„	567.	„	27	„
„	$11/8$	„	$27/20$	„	220	„	216.	„	31	„
„	$7/5$	„	$45/32$	„	224	„	225,	„	7	„
„	$10/7$	„	$64/45$	„	450	„	448,	„	7	„
„	$10/7$	„	$36/25$	„	250	„	252,	„	15	„

Some exception has, however, to be made in respect of $81/64$ ($9/8 \times 9/8$) because it is an upper partial of Ri ($9/8$). The same thing may be said of $45/32$ ($9/8 \times 5/4$) or $3/2 \times 15/8 \times \frac{1}{2}$ which is just (Ni), $15/8$ of Pa, and can only be elongated with some difficulty, as in the case of Ni or $15/8$ from Sa. It may be added that the first śruti or Ekaśruti is not a comma of $81/80$, but is a larger frequency of either $25/24$ or $21/20$ as the rāga may require, since we define Dviśruti as equal to $16/15$.

The theory that there are 22 pitches *only* in the octave which are derived from the Sa Pa and Sa Ma bases, does not suffice. The voice stands at particular harmonic notes, which are formed by aliquot parts of Sa and Pa strings or at their simple nodes. The voice generally takes from such harmonic notes a longer reach and then drops to the adjacent note of the selected scale. When

it goes direct to an adjacent note by a measure of a pitch of less than the semi-tone, the adjacent note itself must be a harmonic note. The possible frequencies to *replace* to complex ratios given by Fox Strangways at page 32 which suggest themselves to me are given at pages 74 and 75.

Some further explanation may be added regarding frequency values obtained at nodal points of an oscillating string. It is presumed the tension is constant and only definite lengths of the string vibrate. Let the open string be of frequency 1 :

No. of Divisions 2 :—The note is 2/1.

Do. 3 :—The frequencies counting from the *meru* (the head) are $(3/2)$; $3/1$ at the two nodes.

Do. 4 :—The frequencies counting from the *meru* are $(4/3)$; $4/2$; $4/1$.

Do. 5 :—The frequencies are $(5/4)$; $(5/3)$; $5/2$; $5/1$.

Do. 6 :—The frequencies are $(6/5)$; $6/4$; $6/3$; $6/2$; $6/1$.

Do. 7 :—The frequencies are $(7/6)$; $(7/5)$; $(7/4)$; $7/3$; $7/2$ and 7.

Do. 8 :—The frequencies are $(8/7)$; $8/6$; $(8/5)$; $8/4$; $8/3$; $8/2$ and 8.

Do. 9 :—The frequencies are $(9/8)$; $(9/7)$; $9/6$; $(9/5)$; $9/4$; $9/3$; $9/2$ and 9.

Do. 10 :—The frequencies are $(10/9)$; $10/8$; $(10/7)$; $10/6$; $10/5$; $10/4$; $10/3$; $10/2$ and 10.

Some of these can be recognised from Tables I and II and figure 11, at page 29 and we need concern ourselves only with values between 1 and 4.

Taking the values lying between frequencies 1 and 2, *i.e.*, in the 1st octave, and omitting repeated ratios, we have 1 Shadja ; 10/9 Trisruti Ri ; 9/8 Chatusruti Ri ;

8/7 ; 7/6 septimal third (ga_1) ; 6/5 Sādhārana gāndhāra, Minor third (ga_2) ; 5/4 Antargata Gāndhāra (Ga_1) . 9/7 Tivra Gāndhāra ; 4/3 Suddha Madhyama (Ma_1) ; 7/5 Prati madhyama ; 10/7 Tivra tara madhyama ; 3/2 Pañchama ; 8/5 Suddha dhaivata (da_2) ; 5/3 Trisruti Da (Da_1) ; 7/4 septimal ni (ni_1) and 9/5 Kaisiki nishāda (ni_2).

I must take this opportunity to point out the *incorrect* statement that the Vina is "tuned to equal temperament" as the piano, made by Captain C. R. Day in his book, "The music and musical instruments of Southern India and the Deccan", at page 32, since upper partials can be heard at the frets marked u. p. in figure 11 *vide* p. 29, in Vinas properly tuned, as in Tanjore.

CHAPTER VIII.

SIX MAJOR RAGAS.

1. *Sankarābharana, Mela 29.*

Venkatamakhi Scale.—Sa Ri Ga Ma Pa Da Ni Śa in ascent and descent.

Characteristic Sruits.	Sa	Ri ₂	Ga ₁	Ma ₁	Pa	Da ₂	Ni ₁	Śa
Probable Fre- quencies.	1	9/8 or 10/9	5/4 or 9/7 or 81/64	4/3	3/2	5/3 or 27/16 or 12/7	15/8 or 27/14 or 243/128	2

In actual violin practice, Ri and Da are generally played Ga Ri and Ni Da respectively, the higher notes being touched first. There is a meaning in this. It is easy for the voice to get to Ri $9/8$ from Pa and not from Sa. Sa Ga being a $5/4$ relationship, we get to hi from Ga. Further, these notes Ri and Da do not seem to be steady and cannot be linaka Svaras *i.e.*, without Gamaka, without detriment to the Bhāva of this Rāga. The alternate svaras Ri, Ma and Da are all in Gamaka and oscillating when prolonged. There is peculiar prayoga as Sa Da, Pa in this melody. Again Ni is sometimes played as Ni_2 *e.g.* | Sa Ni Sa | Dha Ni Sa Ri | Ga Ri Sa Ni , Sa Ri | The first two Ni's are Ni_1 (Kakali Nishāda) while the third is Ni_2 (Tivra Nishāda), higher than Ni_1 but in Gamaka; Kuranji Rāga has also this Ni_2 when it ends in that note in Gamaka.

To my knowledge, the Rāga *vistāra* (spread or expansion) is made only from Sa Ga and Pa and occasionally Ni. This harmonic Ni $15/8$ is reached in the phrase *Sa Dha Ni, Sa* with effort. At the three svaras Sa Ga Pa the voice stops a long while and the notes are prolonged for some length of time. In the case of other svaras, there is generally always gamaka *e.g.*, in \overline{Ri} , , Ga Ri Sa Sa, Ni , , | Ni is shadja sambandha with gamaka. Similarly *e.g.*, in | Da Ni , Sa | Sa Da, Pa | Ni is Ni_1 and the first Da is *Ni sambandha*.

This does not mean that Ri_1 and Da_1 do not appear at all in the rāga. In Sa Ri, Sa for instance, the Ri is Ri_1 but in gamaka goes even up to Ri_2 or a little higher.

In a janya rāga “Kannada” in the melody (Kṛiti) “Enthakante Kāvalana” the song begins thus Sa Ma Ga Ma , , Ma Da Pa Da , . The first Da is $5/3$ (Trīśruti) and the second is $27/16$ Chaturśruti. It is seen as a grace movement from Da_1 ($5/3$). I have also noticed one instance of Trīśruti Da_1 ($5/3$) in the anupallavi of the song ‘Muthukumaraiyane’ of the composer Guhadasa in Sankarābharana rendered into notation | Ma, Da Da, Pa Ma Ga | “Rathi yothi yodu” | Ma Da has a $5/4$ relationship and it is thus sought to emphasise the relationship $5/4$ characteristic in this rāga.

II. Harikambodi, Mela 28.

Venkatamakhi Scale.—Sa Ri Ga Ma Pa Da ni Śa

Characteristic Śrutis Sa Ri_1 Ga_1 Ma_1 Pa Da_1 ni_1 Śa

Possible frequencies

1,	$10/9$	$5/4$	$4/3$	$3/2$	$5/3$	$7/4$	2
	or				or	or	
	$9/8$	$81/64$ (?)			$27/16$	$16/9$ (?)	
		or				or	
		$9/7$				$9/5$	

I shall write in detail about the most commonly sung Janya rāga of this root rāga, *Kāmbodi* (Sa Ri Ga Ma Pa Da Śa, Śa ni Da Pa Ma Ga Ri Sa) with special prayogas Ma Ga Pa Da Śa and an occasional Śa Ni Pa—apparently to have symmetry with Ma Ga Sa. In this rāga, the first prayoga to be noticed is Ri , , , Pa Ma Ga. Here Ri is Ri_2 (Chatur Ri) since the ratio Pa to Ri is $4/3$; but this is in gamaka. Another important feature is that Da_1 can be prolonged to any number of mātras in time e.g., in varnam ‘taruni’ the svaras sung are Da , , , , ,

ni Pa Da ni ni Da etc. The important feature being Da_1 , the Ri should *not* be linaka at all, as Ri_2 is a stronger note heard in relation to Pa of the drone. Hence it is $5/3$ (Trīśruti Da). Hence the concordance noticed with Sa , which is *not the case with Da_2 of Sankarābharana*. To balance the rāga, the music stands also at Ga_1 for a short while. Also notice the prayoga Da Ma Da , , , since $Da = 5/4$ of $4/3$. In the phrase | Da Sa | Da Ri, Ri | Ri_1 should be used. Dha ($27/16$) rarely occurs at all. The prayoga Ma ni and ni Ma in this, as well as in Malavi, a janya rāga, where this is an important feature, *may* justify the use of $16/9$, as a gamaka from Da ($5/3$); but I think $7/4$ is more commonly used when prolonged, as in Surati. ni is either very short or is generally in gamaka in this rāga. The notes, which we generally expand Kāmbodi rāga from, are, to my knowledge, Sa Ga Pa Da. These have values 1, $5/4$, $3/2$, $5/3$, the other śvaras Ri Ma ni, all being in gamaka, when elongated.

III. Kalyani. Venkatamakhi Scale. Mela 65

Sa Ri Ga ma Pa Da Ni Śa

The characteristic śrutis are :—

Sa Ri, Ga, ma, Pa Da, Ni, Śa

Possible frequencies are

1	$10/9$	$5/4$	$7/5$	$3/2$	$5/3$	$15/8$	2
	$9/8$	$81/64(?)$	$45/32(?)$		$27/16$	$\frac{243}{128} (?)$	
		or	or		or	or	
		$9/7$	$10/7$		$12/7$	$27/14$	

The stopping places and the linaka notes are Sa Pa and Chaturśruti Ri; the Āndola and Kampita Gamakas are noticeable in all the svaras (excepting Sa and Pa) and even in Ri. One may ask whether Ri_1 (Trisruti Ri), Ga_1 (Antaragata Ga), Da_1 (Trisruti Da) do not appear at all. They are noticeable especially in descent, and when the pañchama is discarded in the phraseology, but we rarely indeed play Ga together with Pa the open string, and I don't at all. In Pa ma Pa, the ma is sharper. But in descent ma is generally softer. The fall | Pa Ri | is more in vogue than | ma Ri | in this rāga in the major compositions.

IV. *Kharaharapriya*. Venkatamakhi Scale. Mela 22.

Sa Ri ga Ma Pa Da ni Śa

The characteristic śrutis as found in to-day's music are :—

Sa Ri_2 ga_2 Ma_1 Pa Da_2 ni_2 Sa

This rāga seems to have itself undergone transformation. In the earlier compositions of Thiagaraja, Ri is Trisruti, gāndhāra is Madhya gāndhāra and Da Trisruti and ni Madhya nishāda. See 'Korisevimparāda' starting-Pa, Da ni Da, ni etc.

The possible frequencies are :

1	10/9	7/6	4/3	3/2	5/3	7/4	2
	or	or			or	or	
	9/8	6/5			27/16	16/9	
						or	
		32/27 (?)				9/5	

In 'Pakkala nilabadi', a later composition of that composer, the change seems to have been made so as to distinguish it from Bhairavi at certain places; the stopping places are Sa Pa and Ri, the rest in Kampita or Āndola gamaka. In the Anupallavi of 'Chakkani Rāja' the piece itself starts with Da (5/3), *vide* word chi of Chikkani pālu.

V. *Bhairavi*. Venkatamakhi Scale. Mela 20.

Sa Ri ga Ma Pa da ni Śa
or
Da

The characteristic śrutis are:—

Sa Ri₁ ga₁ Ma Pa Da₁ ni₁ Śa
(and da₁ in descent)

The phrases Sa Ri ga Ma and Pa da ni da are permitted.

Possible frequencies

1	10/9	7/6	4/3	3/2	5/3	7/4
	9/8	6/5				16/9
		32/27 (?)			27/16 (?)	9/5 2

and in descent da 8/5, or 14/9 or 13/8

The phrase Ma ni da Pa rules the rāga. In this phrase the ni has sometimes to be Madhyama or Madhyama *i.e.* 16/9; again ga is always weak, and is seen probably to be 7/6, especially when we say sa ga Ri ga. Ri is 10/9. The stopping places are Sa Pa and Ma only.

My ruse, so as not to lose the rāga bhāva, is to fix my mind on Ri₁ and Da₁ in Bhairavi; while in Kharaharapriya I hold on to Ri₂ (9/8) Chaturśruti and ni₂ 9/5

(Kaisikinishāda) and naturally the svara Da_2 gets there fore raised to 27/16 in play.

VI. *Hamumathodi*. Mela 8.

Svaras. Sa ri ga Ma Pa da ni Śa (Generally in ascent in playing, ni is Śa ni, ga is Ma ga.

Characteristic

śrutis. Sa ri_1 ga₁ Ma Pa da₁ ni₁ Śa

Possible frequencies.

1	21/20	7/6	4/3	3/2	14/9	16/9 (?)	2
	or	or			or	or	
	16/15	6/5			8/5	9/5	
		or				or	
		32/27 (?)			13/8	7/4	

The symmetry in Sa Pa strings is not affected by Sa ri_2 ga₂ Ma Pa da₂ ni₂ Sa and yet the South Indian delights largely in the flatter notes of ri_1 ga₁ da₁ and ni₁.

The stopping places Sa Pa and Ma and da₂ are notes where the voice stops very frequently. Pa is occasionally omitted in ascent and when Ma da ni Sa is stressed, ni becomes ni₁. All the notes ri ga da and ni seem to fall by a small interval as the occasion may require in the Kampita gamaka and the Āndolika gamaka. The da and ri are occasionally seen on vina play by a pull from below the head of Pa and Sa strings: also ga₁ is produced from Ri fret.

Again ni_2 in ascent from da_1 is *as far as possible* avoided, so as not to confuse this with the rāga Hindola or Hindustāni malnkos, having svaras,

| Sa ga Ma da ni Śa | Śa ni da Ma ga Sa. In Hindola ga becomes ga_2 , and so the ni also raises itself to ni_2 .

CHAPTER IX.

RĀGAS KANAKĀNGI AND CHALANĀTA

In the six rāgas we have been considering, the intervals Sa Ma – Pa Sa – and Ri_2 Pa – are Suddha Madhyama intervals. This interval consists of one major tone, one minor tone and one semi tone or mathematically $4/3 = 9/8 \times 10/9 \times 16/15$. These three intervals are distributed in the orders possible between Sa Ma and Pa Sa in the five Suddha Madhyama rāgas and between Ri_2 and Pa in Kalyani rāga.

In the other rāgas of South India, that is in the other scales, an attempt is made to have a larger interval than a major tone. One such interval is $6/5$. So $4/3$ can be made up of, as follows:— $6/5 \times 25/24 \times 16/15$. Any order of these three ratios can be thought of between Sa and Ma, and similarly Pa and Śa, and Ri_2 and Pa.

$7/6$ is also a ratio, which is just lower than $6/5$, but we shall leave out that for the present.

Let us now consider two typical rāgas of Kanakāngi the first mela and Chalanāta, the last mela of the 36 Suddha Madhyama melas, or types.

I. Kanakāngi	Sa	ri	(ga)	Ma	Pa	da	(ni)	Śa
Rel. Freq.	1	25/24	10/9	4/3	3/2	25/16	5/3	2

One can ask whether the two ratios of $25/24$ and $10/9$ can be pronounced consecutively. Yes, it is just possible with a slight break in the continuity, and similarly, the ratios of $25/16$ and $5/3$; it is however avoided and the phrasing generally takes such as the following groups | (ni) Sa ri | (ga) Ma Pa. By such phrasing a delightful effect is produced and this has been exploited on.

II. Chalanāta.

<i>Svaras.</i>	Sa	(Ri)	Ga	Ma	Pa	(Da)	Ni	Śa
<i>Rel. Fre.</i>	1	$6/5$	$5/4$	$4/3$	$3/2$	$9/5$	$15/8$	2

Even in the major composition of Thiagaraja, *Jagādānda* in rāga Nāta the phrase Sa (Ri) Ga Ma occurs barely three or four times. The music, somehow or other, steps off to Ga Ma Pa in the ascent and to Pa Ma (Ri) in the descent. The phrase Pa (Da) Ni is absent in that composition.

I may however add that the svaras and the pronunciation of (ga) and (ni) and of (Ri) and (Da) in the two rāgas above at the proper pitches are resorted to only in svara singing, but as pure vowel sounds there is absolutely no difficulty if one can grasp them. In Nāta, a janya rāga of Chalanāta with svaras Sa Ga Ma Pa Ni Sa in ascent and Sa Ni Pa Ma (Ri) Sa in descent, it is seen that the dodge of pronouncing Ga as a gamaka from Ma is generally followed and the gamaka is sharp so as to raise the pitch of Ga to only 70 cents probably from Ma. The possibility, therefore, of the 70 cents appearing arises most in rāgas where the distance or the interval between the successive notes is raised to that of a minor third,

(harmonic). Again, the interval of $7/6$, the septimal minor third from Sa is also another feature which can occur very much in Prati madhyama rāgas, as for instance, in Subha Pantu varāli, when the rāga takes the twist Sa ga ri ga.

I may close this chapter with some examples as to how we can intellectually conceive what śrutis ought *not* to come in at all, when the juxtaposition in the ordinary svaras of the rāga has been given.

Let us consider Ābhogi (in mela 22)

| Sa Ri ga Ma Da Śa | Śa Da Ma ga Ri Sa |

ni is varjya (absent) as also Pa

The possible ratios are :—

1 10/9 32/27 4/3 5/3 2

or
7/6

Sa Ri₁ ga₁ Ma₁ Da₁ Sa

Svara Ri is Triśruti Ri and is the same in descent. Surely Ri₂ = $9/8$ should not come in—being the fifth of Pañchama which does not appear in the music, and it would be un-aesthetic to elongate it 'linaka', as the svara would be unconsciously raised to Ri₂ when we play the note straight in Pa steel string, further Da being (Triśruti) associated and coming next to Ma.

Sriranjani.

Sa Ri ga Ma Da ni Śa

Śa ni Da Ma ga Ri Sa.

Owing to the absence Pa and the prominence of Ma, the same argument as stated in Ābhogi will apply. Da will be ordinarily Triśruti as also Ri and in fact, Thiagaraja uses in the melody Ma Ri₁ ga always, whenever possible.

CHAPTER X.

RHYTHM OR TĀLA.

In Indian music, Rhythm or Tāla may be said to be the summation of units of time (Kāla). Some kritis are in *tsavuka* (elongated) time measure, while some are in Madhyamakāla or ordinary measure.

Leaving aside complicated time measures, the greatest musical compositions of South India are only in 4 tāla types, which can be represented by the numbers 8, 7, 6, and 5 as units of time, commonly named the *Ādi* tāla, *Chāpu* or *Tripata* tāla, *Rūpaka* tāla and *Jampa* tāla respectively, and the music goes on in such cycles.

The number 8 may be said to be equal to

$4 + 2 + 2$. Ex. Sa ri Ga Ma | Pa da | Ni Sa
or $2 + 2 + 2 + 2$.

The number 7 = $4 + 3$ or $3 + 4$. Ex. Sa ri Ga | Sa ri | Ga Ma |
or $3 + 2 + 2$.

The number 6 = $2 + 4$. Ex. Sa ri | Sa ri Ga Ma |
or $2 + 2 + 2$.

The number 5 = $2 + 3$. Ex. Sa ri | Sa ri Ga |
or $3 + 2$.

The above units (the technical word is akshara) may be doubled if necessary, as 16, 14, 12 and 10. If we do so, there is no change in the method of summation, of the numbers 16 and 12 which are just double in each

case, while there exists a difference in the summation in numbers 14 and 10.

14 = 5 + 5 + 2 + 2. Ex. Sa ri, Ga, | Sa, ri Ga, | Ma, |
Ma, | or Aṭa tāla.

or 14 = 4 + 2 + 4 + 4 Ex. Sa ri Ga Ma | Ga ri |
Sa ri Ga ri | Sa ri Ga Ma |
or Dhruva Tāla.

10 = 7 + 1 + 2. Ex. | Sa ri Ga Sa ri Sa ri | Ga | Ma,
Jampa Tāla.

or 10 = 4 + 2 + 4 Ex. | Sa ri Ga ri | Sa ri | Sa ri Ga Ma |
Maṭya Tāla.

The next question to ask ourselves is 'where are the stresses and strains', as it were, in these time measures? In South Indian music, the rhythm in the music of a singer is represented by a beat (to produce a sound) and finger counts, [the counting by fingers after taking the beat as no. 1, is done as 2, 3, 4, 5, 6, 7 as may be needed, by the little finger, for the second; the ring finger, for the third; the middle finger, for the fourth unit; the index finger for the fifth; the thumb for the sixth; and the little finger for the seventh (without a beat)¹, or by a beat and a throw of the hand, or by a beat alone.

(The technical name for beat and count is *laghu*.

„ „ beat and throw is *Dritam*.

„ „ beat alone *anudṛita*)

I. Time measure of 8 units.

If summed as 4 + 2 + 2, the beats, counts and throws are as below.

Beat	3 Counts	Beat Throw	Beat Throw
	1+1+1+1	1+1	1+1
and similar repetitions.			

If summed as $2 + 2 + 2 + 2$, it is really taken as

Beat beat beat throw

$1 + 1 + 1 + 1$ (i.e., 3 beats and 1 throw for each quarter of the whole time measure.

II. (a) *Time measure 7 units.* We may sum up as $3 + 4$ or $4 + 3$ or $3 + 2 + 2$.

Case $3 + 4$; | 1 beat + 1 + 1 | 1 beat + 1 + 1 + 1 |

Case $4 + 3$; | 1 beat + 1 + 1 + 1 | 1 beat + 1 + 1 |

There may be no counting here at all in both the above cases.

We have case $3 + 2 + 2$; | 1 beat + 2 counts | 1 beat + 1 throw and | 1 beat + 1 throw |

(b) 7 units may be doubled as 14.

Case $14 = 5 + 5 + 2 + 2$; we have then

| 1 beat + 4 counts | 1 beat + 4 counts | 1 beat + 1 throw |
and 1 beat + 1 throw |

(c) Case $14 = 4 + 2 + 4 + 4$; we have then

| 1 beat + 3 counts | 1 beat + 1 throw | 1 beat + 3 counts |
and 1 beat + 3 counts—

III. *Time measure 6.*

Case $6 = 2 + 4$; we have | 1 beat + 1 throw | 1 beat + 3 counts

Case $6 = 2 + 2 + 2$, the three measures are treated as equal, and we have | 1 beat + 1 beat + 1 throw |

IV. (a) *Time measure 5*; we have

Case $5 = 2 + 3$ | 1 beat + 1 throw | 1 beat + 2 counts |

(b) If the measure is doubled as 10, we may treat

$10 = 7 + 1 + 2$, we have then

| 1 beat + 6 counts | 1 beat | 1 beat + 1 throw |

IV. (c) or $10 = 4 + 2 + 4$; we have then

| 1 beat + 3 counts | 1 beat + 1 throw | 1 beat + 3 counts |

The next question is, where does the music begin, at the first beat or elsewhere?

Regarding the 8 units time measure, there are 5 ways. This music of 8 units is generally written in 32 sub-units.

1st unit	2nd Unit	3rd Unit	
1 2 3 4	1 2 3 4	1 2 3 4	and so on.
$\frac{1}{@}$	$\frac{3}{@}$	$\frac{4}{@}$	$\frac{1}{@}$ $\frac{3}{@}$

(a) We can start music at 1/1 or at 1/3 or at 1/4, *vide* sign @, the numerator showing the unit and the denominator showing the sub-unit measure at which the music may start. That is, at the commencement itself of the beat or leaving off either *two or three sub-units* of the 32 units. The beat is always at 1/1 where the music joins later.

(b) Or it may start even at the commencement of the second unit that is, at 2/1 or it may even commence at 2/3. In the last two cases, we can consider as if the whole time measure is divided into 16 sub-units and that the music commences after leaving off 2 or 3 of the 16 sub-units, of course joining up later again.

Regarding the 7 *akshara* measure the music may start with the beat in the summation $3 + 4$ or $4 + 3$. See page 89. Or at the sign @ as below.

	$\frac{1}{@}$
1 beat + 1 + 1	+ 2 + 2
	$\frac{2}{@}$
or 2 + 2	+ 3

When the measure is 14 units, the music may start

©

at the 1st beat or at the sign @ | 2 + 3 | 5 | 2 | 2, that is after leaving 2 akṣaras out of the 14, the music starting with the ring finger where the count begins, and joining up, of course at the beat of the first mātra.

Regarding the time measure 6, the music may also start at the throw or at the second beat itself, *vide* ④

ⓐ

$| 1 + 1 | \quad | 1 + 1 + 1 + 1 |$

Regarding the five unit measure the music may

start elsewhere than at the beat thus, *vide* sign @ | 1+1
1 beat + 1+1 |

Examples of each case of the above are given in the following pages. The notation will certainly in my opinion serve the purpose of an *All-India* Notation for music.

8 MĀTRAS MEASURE.

Rāga Sankarābharana

Case	1	2	3	4
I	Pa, Ma, Pa,, Ma	Ga Ma Pa Ma Ma Ga Ga Ri		
	Ma ri ya			da
	5	6	7	8
	Ri Ga Ri Sa Sa, Sa Ni Sa, Ri, , Ga, Ma			
	ga			du ra

The music starts at the commencement of the first beat.

Rāga Sankarābharana

Case	1	2	3	4
II	** Pa , ,	Mā Pa , ,	Ma	Ga , Ma Ri Ga ,
	Ra	ga mu		ta la mu
	5	6	7	8
	; Ga Ma Pa Ma Ga ,		Ri Ga Ma Ga Ga Ri Sa ,	
	Ra	kti bha	kti	jna na
	1			
	;			

The music starts after leaving half of the first unit.

Rāga Harikāmbodhi.

Case	1	2	3	4
III	*** ni Da , ,	ni Śa , ,	ni Da ni Śa , ,	ni Da ,
	En	ta ra	ni	ta na
	5	6	7	8
	; Pa , Da Pa Pa Da ni Śa ni ,	Da Pa Ma, Ga Ma		
	ken ta	bo	ni	nee
	1			
	Pa Da Pa.			

The music starts after leaving three-fourths of the first unit.

Rāga Begada

Case	1	2	3	4	5	6	7	8
IV	** Ma , ,	Ma Ga	Ga ,	Ma ,	Pa , ,	Da Pa ,		
	; na	do		pa		sa na		

Music written in 16 sub-units.

The music starts at the second unit.

Rāga Khamāj

Case	1	2	3	4	5	6	7	8
V	***	Ma	Ma Ga	Ga Ma Pa	Ma	Ma	ni Da	ni Da
		Si	ta	pa	tee	na	ma	na su
	Pa			The music written in 16 sub-units,				
	na							

The music starts leaving off the first unit and a half of the 2nd unit.

Notice in the last case that the 2nd half of the whole measure will start generally with 3 sub-units of the 16 sub-units.

Seven Mātras measure [Rāga Ritigaula 7 = 3 + 4.]

I | 1 | 4 | 1 | 4 | 1 | 4 |
ni ni , Sa , ni , ga Ri , Sa , ;	; , ; Sa ni	
ja na nee nin	nu vi na	tri
1	4	
Da ni Sa ni Da Ma,		
lo ka		

The music starts at the first unit of the group of three units.

Rāga Purva-Kalyāṇi here 7 = 4 + 3.

1 5 1 5 1 5 1 5

II | Sa , Da, Sa Sa, | ; Da , Sa ri, | Ga , ri, Ga Ga, | ; ri , , Sa, |

| ni nu vi na | ga ma ri | di ke va ru | na |

The music starts at the first unit of the group of four units.

Rāga Kharaharapriya here $7 = 3 + 2 + 2$.

III	1	2	3	4	5	6	7	
	, ,	Pa,	Da,	ni,	, ,	ni	Da	Da Pa
		pa		ka		la		
	1			4			6	
	Sa	, ,	Sa	ni	ni ,	ni	Da	Da Pa Pa Ma Ma , ;
	ni		lu		ba			di

Aṭa Tāla (14 Units) Vasanta Rāga.

1	2	3	4	5
Ma Ga Ma , Da , ;	Śa Ni Da Ma	Śa Ni Śa ri	Śa , ;	
Na ta nam	ā		di	nar
6	7	8	9	
Śa Ni	Śa , ri Śa , Ni Da Ma	Da Ni Śa Ni		
ve hu	na ga ree ga ma	ha ve ka na		
		10		
		Da Ma Ma Ma		
		ka sa bhai yil		
11	12	13	14	
Sa Ni Da Ni Da Ma	Ma , ; Ga ri	Ga ri Sa Ni		
A	nam	da		

The music starts at the commencement.

6 Unit Measure 6 = 2 + 2 + 2.

Rūpaka. Rāga Māya Mālava Gauḷa.

1	2	3	1	2	3
I Ni da Pa , , Ma Ga Ma Pa da Pa Ma Ga , Ri Sa Ni					
Tu la see	da la mu	la	che sa	m	
1	2	3	1	2	3
Sa ri Ga Ga Ga , Ga Ma Pa Pa Ma Ga Ma					
tho sha mu ga poo	ji	ntu			

The music starts at the commencement.

Rāga Māya Mālava Gauḷa here 6 = 2 + 4

music written in 12 sub-units.

1	2	3	1	2	3
II , , da Pa Ma Ga Ma , Pa , da , Pa , ; Pa , da Ni da , Pa ,					
1 san ta ta mu ci va sma ra na va					
da Ma					

The music starts, after leaving half of the first unit.

Kalyāṇi

1	2	3	1	2	3	1	2	3	1
III, ,	Ri	Sa ,	Sa	Ri	Ri ,	Ga ,	ma	Pa , ;	Pa ma Ga Ri
bhi	ra	na	va	ra	lee	chi	bro - vu	mu	ni nu
								2	3
								Pa	ma Ga ,
								ne	ra nam

1	
Ri Sa	
mi ti	

Music written in 6 units; Music starts with the 2nd beat or the beginning of the group of 4 units.

Sankarābharana.

Here 6 units = 2 + 2 + 2 ; music written in 12 sub-units

beat	beat	throw
------	------	-------

2

	1	(Ga)	(Ga)	3	
* * * Ma	Ga	Ri	Sa	Ri	Ri Ga , Ma
mu	du	— —	Ku	ma	rai ya ne

an odd case, the music starting just one sub-unit before the first beat.

Or the music may be considered alternatively as commencing at $\frac{1}{2}$ the throw, (lying in the first portion which starts with a beat and a throw) the word of the melody 'du', being the commencement of a beat and 3 counts.

3	4	5	6	1	2
Ma	Ga	Ri	Sa	Ri	Ri Ga , Ma
Mu	du	ku	Ma	rai	ya ne

here 6 - 2 + 4

*Jhampa Tāla, 5 Units (written as 10 sub-units)**Madhyamāvathi.*

1	2	3	4	5	1	2	3	4	5
ni ,	;	Sa,	Ri ,	;	Ri ,	Ri ,	Pa	Ma	Ri Sa Ri ,
na		du	pai		pa	li	ke		ru
1	2	3	4	5	1	2	3	4	5
Ri , ,	Ma	Ri , ,	Ma	Ri , ;	Sa,	Sa , ,	Ri	Ri Sa	ni , Pa ,
na		ru		lu		sri	Ra		ma

The music starts at the commencement of Tāla.

*Jhampa of 10 units.**Sāranga.*

	Beat	←———6 counts———→						Beat	Beat	Throw
II (a)	1	2	3	4	5	6	7	8	9	10
	,	Pa	Pa	,	Pa	Pa	ma	ma	ga	ma
	nee	va	—	da	ne	—	ga	—	ma	
	1									
	.									
(b)	1	2	1	2	3	1	2	1	2	3
	,	Pa	Pa	,	Pa	Pa	ma	ma	Ga	ma
	nee	va		da	ne			ga	—	na
	1									

, The music starts leaving off 1 unit.

CHAPTER XI.

'The history of musical forms is, on one hand, the history of invention of instruments and the practice of instrumentation' from JOHN DEWEY'S "Art as experience".

MELA RĀGAS OR SCALES OR MELODY TYPES.

I. *Chakra - Svaras.*

Names	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Kanakāṅgi	Sa	ri	(ga)	*	*	Ma	*	Pa	da	(ni)	*	*	Śa
2. Ratnāṅgi	Sa	ri	(ga)	*	*	Ma	*	Pa	da	*	ni	*	Śa
3. Gāṇamūrthi	Sa	ri	(ga)	*	*	Ma	*	Pa	da	*	*	Ni	Śa
4. Vanaspati	Sa	ri	(ga)	*	*	Ma	*	Pa	*	Da	ni	*	Śa
5. Mānavathi	Sa	ri	(ga)	*	*	Ma	*	Pa	*	Da	*	Ni	Śa
6. Thānarupi	Sa	ri	(ga)	*	*	Ma	*	Pa	*	*	(Da)	Ni	Śa

II. *Chakra - Svaras.*

Names	1	2	3	4	5	6	7	8	9	10	11	12	13
7. Senāpati	Sa	ri	*	ga	*	Ma	*	Pa	da	(ni)	*	*	Śa
8. Hanumathodi	Sa	ri	*	ga	*	Ma	*	Pa	da	*	ni	*	Śa
9. Dhenuka	Sa	ri	*	ga	*	Ma	*	Pa	da	*	*	Ni	Śa
10. Nātakapriya	Sa	ri	*	ga	*	Ma	*	Pa	*	Da	ni	*	Śa
11. Kokilapriya	Sa	ri	*	ga	*	Ma	*	Pa	*	Da	*	Ni	Śa
12. Ropāvatī	Sa	ri	*	ga	*	Ma	*	Pa	*	*	(Da)	Ni	Śa

III. *Chakra - Svaras.*

Names	1	2	3	4	5	6	7	8	9	10	11	12	13
13. Gāyakapriya	Sa	ri	*	*	Ga	Ma	*	Pa	da	(ni)	*	*	śa
14. Vakulābharana	Sa	ri	*	*	Ga	Ma	*	Pa	da	*	Li	*	śa
15. Māyāmālavagaula	Sa	ri	*	*	Ga	Ma	*	Pa	da	*	*	Ni	śa
16. Chakravāka	Sa	ri	*	*	Ga	Ma	*	Pa	*	Da	ni	*	śa
17. Suryakānta	Sa	ri	*	*	Ga	Ma	*	Pa	*	Da	*	Ni	śa
18. Hātākāmbari	Sa	ri	*	*	Ga	Ma	*	Pa	*	*	(Da)	Ni	śa

IV. *Chakra - Svaras.*

Names	1	2	3	4	5	6	7	8	9	10	11	12	13
19. Jhamkāradhwani	Sa	*	Ri	ga	*	Ma	*	Pa	da	(ni)	*	*	śa
20. Natabhairavi	Sa	*	Ri	ga	*	Ma	*	Pa	da	*	ni	*	śa
21. Kiravāni	Sa	*	Ri	ga	*	Ma	*	Pa	da	*	*	Ni	śa
22. Kharaharapriya	Sa	*	Ri	ga	*	Ma	*	Pa	*	Da	ni	*	śa
23. Gourimanohari	Sa	*	Ri	ga	*	Ma	*	Pa	*	Da	*	Ni	śa
24. Varunapriya	Sa	*	Ri	ga	*	Ma	*	Pa	*	*	(Da)	Ni	śa

V. *Chakra - Svaras.*

Names	1	2	3	4	5	6	7	8	9	10	11	12	13
25. Māraṇjani	Sa	*	Ri	*	Ga	Ma	*	Pa	da	(ni)	*	*	śa
26. Chārukesi	Sa	*	Ri	*	Ga	Ma	*	Pa	da	*	ni	*	śa
27. Sarasāngi	Sa	*	Ri	*	Ga	Ma	*	Pa	da	*	*	Ni	śa
28. Harikāmbodhi	Sa	*	Ri	*	Ga	Ma	*	Pa	*	Da	ni	*	śa
29. Dhira Sankarā- bharna	Sa	*	Ri	*	Ga	Ma	*	Pa	*	Da	*	Ni	śa
30. Nāganandini	Sa	*	Ri	*	Ga	Ma	*	Pa	*	*	(Da)	Ni	śa

VI. *Chakra - Svaras*

	Names*	1	2	3	4	5	6	7	8	9	10	11	12	13
31.	Yāgapriya	Sa	*	*	(Ri)	Ga	Ma	*	Pa	da	(ni)	*	*	Sa
32.	Rāgavardhini	Sa	*	*	(Ri)	Ga	Ma	*	Pa	da	*	ni	*	Sa
33.	Gāṅgeyabhushani	Sa	*	*	(Ri)	Ga	Ma	*	Pa	da	*	*	Ni	Sa
34.	Vāgadhiswari	Sa	*	*	(Ri)	Ga	Ma	*	Pa	*	Da	ni	*	Sa
35.	Sulini	Sa	*	*	(Ri)	Ga	Ma	*	Pa	*	Da	*	Ni	Sa
36.	Chalanāta	Sa	*	*	(Ri)	Ga	Ma	*	Pa	*	*	Da	Ni	Sa

*The names as used in the composition 'Mela Rāga Malika' of Maha Vaidhyanatha Sivan are given here. In each melodic portion, the name of the Mela is given.

As an exception to the *Nota Bena* at Page 4, I may mention that in *Svara Singing*, *Shadśruti Dhaivata* | (Da) | is pronounced stressed as Dha at the pitch (9/5) ni 2.

The above six *chakras* (groups) are all of *Suddha Madhyama* rāgas, that is to say, they take only *Suddha Madhyama* in their melodies. The next 36 rāgas are *Prati madhyama* rāgas. They do not take the *Suddha Madhyama* at all, but take only *Prati madhyama*. If one substitutes *Prati madhyama* for *Suddha Madhyama* in the above six *chakras* respectively, we get the corresponding rāgas of the *Prati madhyama* *chakras*, and I give only their names to avoid repetition, as the system of division is clear enough.

VII. Chakra.

37. Sālaga.
38. Jalārnavam.
39. Jhālāvārāli.
40. Navanitham.
41. Pāvani.
42. Raghupriya.

VIII. Chakra.

43. Gavāmbodhi.
44. Bhavapriya.
45. Subhapantuvarali.
46. Shadvidhamārgini.
47. Suvarnāngi.
48. Divyamani.

IX. Chakra.

49. Dhavalāmbhari.
50. Nāmanārāyani.
51. Kānavardhini.
52. Rāmapriya.
53. Gamansrama.
54. Visvambhari.

X. Chakra.

55. Syāmalangi.
56. Shanmukhapriya.
57. Simhendra madhyama.
58. Haimavati.
59. Dharmavati.
60. Nitimathi.

XI. Chakra.

61. Kāntamani.
62. Rishabhapriya.
63. Latāngi.
64. Vāchaspati.
65. Mechakalyāni.
66. Chitrāmbhari.

XII. Chakra.

67. Sucharitra.
68. Jothiswarupini.
69. Dātuvardhini.
70. Nāsikābhushani.
71. Kosala.
72. Rasikapriya.

CHAPTER XII.

JANYA RĀGAS.

The best way of understanding the Bhāva of a janya rāga is to record its *Sanchāra*, or the order of āroha and avaroha svaras, of the Scales in which they can be given a *niche*.

I say this especially because the śrūti (or the particular twin notes of the svaras) could be easily ascertained with reference to Sa, Ma and Pa, so as to maintain as far as possible a musical interval between successive svaras. Of course, some few rāgas can be given a niche in one or more of the Melakarta rāgas, but as long one knows what svaras we use, we need not worry much on the *score* of the scale.

A list of the more important janya rāgas, in which has been successfully achieved a *totality of aesthetic effect* in modern Rāga ālāpana, is given below. Some Vernacular books have given the mere Sanchāra-krama that I first felt it needless to copy them. I however propose to add a remarks column to show the Viśeṣa (special) Sanchāras of these rāgas and the non-permissible Svara combinations, which should be avoided, so as not to cause confusion of rāga Bhāva with allied rāgas.

The Music Academy, Madras has published a pamphlet in English, of rāgas, wherein rāga lakṣhanas are given as they were discussed in the proceedings of several years. A selection therefrom, has been rearranged by me, according to melakarta with my own remarks and observations, as the said pamphlet is sometimes too *laconic* in characterisation.

Hanumathodi, Mela 8.

1. Dhanyāsi.

Ār. Sa ga Ma Pa ni Śa

Av. Śa ni da Pa Ma ga ri Sa

Phrases Sa ri ga ri and Pa da ni da are *not* permissible.

2. Punnāgavarāli.

Ār. ṇi Sa ri ga Ma Pa da ni,

Av. ni da, Pa Ma gaa ri Sa ṇi

Higher Sa is not reached in this rāga. It more often takes Ri₁ in ascent and in the phrase ga Ri ga. In descent it is always ri.

3. Asāveri.

Ar. Sa ri Ma Pa da Śa

Av. Śa ni Śa Pa da Pa Ma gaa ri Sa

The rāga takes Ri₁ occasionally in ascent and Pa da ni da Pa is permissible.

4. Hindola.

Ār. Sa ga Ma ni da ni Sa

Av. Sa ni da Ma ga Sa

Pa as well as ri is Varjya, absent.

Māyamālava Gaula, Mela 15.

1. Sāveri.

Ār. Sa ri Ma Pa da Śa

Av. Śa Ni da Pa Ma Ga ri Sa

Phrases Sa ri Ga Ma and Pa da Ni Sa are *not* permissible.

2. Nādanāmakriya.

Ār. N̄i Sa ri Ga Ma Pa da Ni

Av. da Pa Ma Ga ri Sa N̄i

Special feature Sa ri Ma, Ga ri Ma Ma.

3. Ganla.

Ār. Sa ri Ma Pa Ni, Śa

Av. Śa Ni Pa Ma Ga Ma rii Sa

ri and Ni are *moorchana* Svaras. ri Ga Ma ri Sa a special feature.

4. Gauli Pantu.

Ār. Sa ri Ma, Pa Ni, Śa

Av. Śa Ni da Pa Ma Pa da Ma Ga rii Sa

ri and Ni are *moorchana* Svaras and are in Gamaka when elongated.

5. Bhauli.

Ār. Sa ri Ga Pa da Śa

Av. Śa Ni da Pa Gaa ri Sa

Sa Ni is really played as Sa Sa with the background Ni.

6. Revagupti.

Ār. Sa ri Ga Pa da Śa.

Av. Śa da Pa Ga ri Sa.

7. Pharaz.

Ār. Sa Ga Ma daa Ni Śa

Av. Sa Ni da Ma Ga Ma Pa da Pa Ma Ga ri Sa

In one of the Kritis of Syama Sastri, Nilāya Tākshi, Pa has been entirely omitted, except for one instance.

Nata Bhairavi, Mela No. 20.

1. Bhairavi has been dealt with in Chapter VIII.

2. *Suddha Dhanyāsi.*

Ār. Sa ga Ma Pa ni Sa

Av. Sa ni Pa Ma ga Sa.

3. *Madhyamāvati.*

Ār. Sa Ri Ma Pa ni Śa

Av. Śa ni Pa Ma Ri Sa.

4. *Mānji.*

Ār. Sa Ri ga Ma Pa da ni Śa

Av. Śa ni da Pa Ma Pa gaa Ri Sa

Use of Da in ascent is alike Bhairavi. The phrase ga Pa is common and ga is long : *There is an elusive difference* between Bhairavi and Mānji, in the matter of Bhāva.

^
Karaharapriya Mela 22.
^

1. *Sriranjani.*

Ār. Sa Ri ga Ma Daa ni Śa

Av. Śa ni Da Ma Ri gaa Ri Sa.

2. *Ritigaula.*

Ār. Sa ga Ri ga Ma ni ni, Śa

Av. Śa ni Da Ma ga Ma Pa Ma ga Ri Sa

ni Pa ni ni Sa; Sa ga ga Ma and

an occasional Pa da Pa are found in all compositions, also Pa Da ni ni Da Ma in Syama Sastri's composition.

3. Sri

Ār. Sa Ri Ma Pa ni Śa

Av. Śa ni Pa Ma Ri ga Ri Sa

4. Kānada.

Ār. Sa Ri ga, Ma Da ni Śa

Av. Śa ni Pa Da ni Da Pa Ma Pa gaa

Ma Ri Sa ni Sa Da ni Sa

5. Darbār.

Ār. Sa Ri Ma Pa Da ni Śa

Av. Śa ni Da Pa Ma gagga Ri Sa

Special features (1) Da ni Pa (2) Śa ni Śa Da, Pa (3) Ri ga, Ri Sa, the sound ga gga is perhaps Ri , , Ma Ri , , Ma.

6. Nāyaki.

Ār. Sa Ri Ma Pa Da nii Da Pa Śa

Av. Śa ni, Da Pa Ma Ri gaa Ri Sa

7. Ānanda Bhairavi.

Ār. Sa ga, Ri ga Ma Pa Da Pa Śa

Av. Śa ni Da Pa Ma ga Ri Sa

Phrases | Pa da Pa, | Pa ni Śa, | are used. I would however deprecate the recent use of Ga and Ni in this rāga, as bhāva of Nilāmbari is suggested.

8. Huseni.

Ār. Sa, Ri ga Ma Pa, Da Ni Śa

Av. Śa ni da Pa, Ma gaa Ri Sa

The Rāga usually takes the form Sa Pa, Pa ni Da Ma | Pa ni Da ni Śa, | Ri Śa ni Da Pa Ma, | Pa Da ni Pa da Pa | Ma ga Pa Ma ga Ri Sa |

9. Mukhāri.

Ār. Sa Ri Ma Pa ni Da Śa

Av. Śa ni da Pa Ma ga Ri Sa

Phrase Pa Da Sa is getting common also. Pa ni Da Ma is used.

10. Kāphi.

Ār. Ni Sa Ri Ma Pa ni Śa

Av. Sa ni ni, Da Pa Ma ga ga, Ri Sa.

Also Sa Ri ga Ma Pa Ma ga Ri Sa is used. The use of Ga and da has been copied from Hindustāni music.

11. Devamanohari.

Ār. Sa Ri Ma Pa Da ni Śa

Av. Sa ni Da, ni Pa Ma Ri, Sa.

Hari Kāmbodi Mela 28.

1. Kāmbodi has been dealt with in Chapter VIII.

The Sa Sa Pa phrase has become the occasional Sa Ni Pa.

2. Kedāragaula.

Ār. Sa Ri Ma Pa ni Śa

Av. Śa ni Da Pa Ma Ga Ri Sa.

Phrase Sa Ri Ga Ma is not permissible.

3. Surati.

Ār. Sa Ri Ma Pa ni Da ni Śa

Av. Śa ni Da Pa Ma Ga Pa Ma Ri, Sa.

An occasional Pa ni ni Sa also is permissible.

4. Yadukula Kāmbodi.

Ār. Sa Ri Ma | Ga Ma Pa, Da Śa |

Av. Śa ni Da Pa Ma Ga Ri, Ma Ga Sa.

Also Phrase Ri, Ga Sa in descent is permissible.

5. Khamās.

Ār. Sa Ma Ga Ma Pa Da ni Śa

Av. Ri Śa ni Da Pa Ma Ga Ri Sa

Ma is the Moorchana Svara.

6. Mohana.

Ār. Sa Ri Ga Pa Da Śa

Av. Śa Da Pa Ga Ri Sa

7. Sahāna.

Āv. Sa Ri, Ga Ma Pa Ma Da, ni Śa

Av. Śa ni, Da Pa Ma Ga, Ma Ri, Ga Ri Sa

Once in a way Ri Ga Ma Pa Da ni Śa is allowed.

8. Nāta Kuranji.

Ār. Sa Ri Ga Ma, ni Da ni Pa Da ni Śa

Av. Śa ni Da Ma, Ga Ma Pa Ga Ri Sa

Phrases Ga Ma Ga Sa and Sa Ri Ga Ma | Pa Ga Ri Sa | are permissible.

Sa Ri Ga Ma Pa Da ni Sa is *not* allowed.

9. Senjurati.

Av. Pa Da Sa Ri Ga Ma Pa Da

Av. ni Da Pa Ma Ga Ri Sa ni Da Pa

Rāga from lower Pa to ni of mid octave, an occasional Sa Ri Ma ga Ri is used.

10. Sāma.

Āv. Sa Ri Ma Pa Da Śa

Av. Śa Da Pa Ma Ga Ri Sa

Ri, is an oscillating note. The Sanchārakrama looks like Ārabhi but there is a difference in Bhāva.

11. Balahamsa.

Ār. Sa Ri Ma Pa Da Śa

Av. Śa ni Da Pa Ma Ri Ma Ga Sa

12. Kuntala Varāli

| Sa Ma Pa Da ni Da Śa | Śa ni Da Pa Ma Sa |

13. Navarasa Kannada.

| Sa Ga Ma Pa Śa | Śa ni Da Ma Ga Ri Sa |

Sankarābharana Mela 29.

1. Ārabhi.

Ār. Sa Ri Ma Pa Da Śa

Av. Śa Ni Da Pa Ma Ga Ri Sa

The use of Sa Ni Da Pa is very rare and it is mostly Śa Da Pa.

2. Bilahari.

Ār. Sa Ri Ga Pa Da Śa

Av. Śa Ni Da Pa Ma Ga Ri Sa

An occasional Pa Da ni Da also Pa Da Ni Pa Da Pa is permitted.

3. Begada.

Ār. Sa Ga Ri Ga Ma Pa Da Pa Śa

Av. Śa Ni, Da Pa Ma, Ga Ri Sa

Ma, in descent is oscillating. Ni is Shadja Sambandha (united). See also text.

4. Nilāmbari.

Ār. Sa Ri Ga Ma Pa Ni Śa

Av. Śa Ni Pa Da ni Pa Ma Ga Ma Ri Ma Ga Sa,

Both Ni and ni are used, but mostly Ni gives the rāga Bhāva.

5. Hamsadhwani.

Ār. Sa Ri Ga Pa Ni Śa

Av. Śa Ni Pa Ga Ri Sa

6. **Suddhasāveri.**

Ār. Sa Ri Ma Pa Da Śa

Av. Śa Da Pa Ma Ri Sa

7. **Devagāndhari.**

Ār. Sa Ri Ma Pa Da Ni Śa

Av. Śa Ni Da Pa Ma Ga Ri Sa

Sa Ri Ga Ma, Ga Ri is a special feature.

Also Da ni Da Pa where ni is flat.

8. **Atāna.**

Ār. Sa Ri Ma Pa Ni Śa

Av. Śa Ni Da ni Pa Ma Pa Ga, Ri Sa

Both Ga and Da are oscillating notes in Gamaka. Pa Da ni Da Pa and Sa ni Pa are permissible.

9. **Kedāra.**

Ār. Sa Ma Ga Ma Pa Ni Sa

Av. Śa Ni Pa Ma ~~Ga Ma Pa Da Ma~~ Ga, Ri Sa

Phrase Sa Ri Ga, Sa is a special feature.

10. **Kuranji.**

Ār. Ni Sa Ri Ga Ma Pa Da

Av. Da Pa Ma Ga Ri Sa Ni,

The rāga extends from Ni of lower octave to Da of the mid octave.

11. **Byahag.**

Ār. Sa Ga Ma Pa Sa Ni Sa

Av. Śa Ni Da Pa ma, Pa, Ga Ma Ga Ri Sa.

Phrase Pa Da ni Pa is used.

12. Kannada.

Ar. Sa Ga Ma Da Ni Śa

Av. Śa Ni Śa Da, Pa | Ga Ma Pa | Ga Ri Sa

13. Navaraj.

Ar. Pa Da Ni Sa Ri Ga Ma Pa Da

Av. Pa Ma Ga Ri Sa Ni Da Pa.

Extending from lower Pa to Da of mid octave only.

Mecha Kalyāni Mela 65.

1. Kalyāni. Same as Mecha Kalyāni.

2. Sāranga.

Ar. Sa Ri Ga ma Pa Da Ni Śa

Av. Śa Da, Pa ma Ri Ga Ma Ri Sa

Phrase Sa Ri Ga ma Pa is not permitted.

Really the rāga runs usually as

Sa Ri Sa | Pa ma Pa | Da, Ni Śa

Śa Ni Da Pa ma Ri Ga Ma Ri, Sa

Note use of both Ma and ma.

Miscellaneous.

Janya in Mela 53 Gamanasrama.

1. Purvakalyāni.

Ar. Sa ri Ga ma Pa Da Pa Śa

Av. Śa Ni Da Pa ma, Ga ri Sa

Special features i. Pa Da Ni, Da Pa Śa

ii. Pa Da Śa

iii. ma Da Śa

iv. ma Da Ni ri

Janya in Mela 17 (Suryakānta).

1. Sourāshtra.

Ār. Sa ri Ga Ma Pa Da Ni Śa

Av. Śa Ni Da ni Da Pa Ma Ga Pa Ma Gri Sa

Ni Sa | in āroha is almost | Sa Sa | with a back ground of Ni

2. Vasanta.

Ar. Sa Ga Ma Da Ni Śa

Av. Śa Ni Da Ma Ga ri Sa

Pa is varjya (absent)

Janya in Mela 36.

1. Natai.

Ar. Sa Ga Ma Pa Ni Sa

Av. Sa Ni Pa Ma (Ri,) Sa.

Janya in Mela 14 (Vakulābharana.)

2. Āhiri.

Ar. Sa ri Sa Ma Ga Ma Pa da ni Śa

Av. Śa ni da, Pa Ma Ga Ma ri, Sa

The elongated da is characteristic, and Ma Ga ri Sa is permitted.

Note added in 2nd Eddition : The āroha and avaroha of 15 more janya rāgas are given below since melodies therein have been recorded in gramophone plates.

Mela 22.

Ābheri.

Ar. Sa ga Ma Pa ni Sa

Av. Śa ni Da Pa Ma ga Ri Sa

Kannada Gaula.

Ar. Sa Ri ga Ma Pa ni Śa
Av. Śa ni Da Pa Ma ga Sa

Devatāmṛtavarshani.

Ar. Sa Ri ga Ma ni Da ni Śa
Av. Śa ni Da Pa Ma ga Ri Sa

Jayamanohari.

Ar. Sa Ri ga Ma Da Śa
Av. Śa ni Da Ma Ri Sa

Manirangu.

Ar. Sa Ri Ma Pa ni Śa
Av. Śa ni Pa Ma gaa Ri Sa

Mela 28.

Bahudāri.

Ar. Sa Ga Ma Pa Da ni Śa
Av. Śa ni Pa Ma Ga Sa

Umābharana.

Ar. Sa Ri Ga Ma Pa Da ni Śa
Av. Śa ni Pa Ma Ri Ga Ma Ri Sa

Ravichandrika.

Ar. Sa Ri Ga Ma Da ni Da Śa
Av. Śa ni Da Ma Ga Ri Sa

Mālavi.

Ar. Sa Ri Ga Ma Pa Ma ni Da ni Śa
Av. Śa ni Da ni Pa Ma Ga Ma Ri Sā

Karnāṭaka Byahag.

Ār. Sa Ri Ga Ma Pa Da ni Śa

Ar. Śa ni Da ni-Pa Da Ma-Ga Ri Ga Sa

*Mela 29.***Purnachandrika.**

Ar. Sa Ri Ga Ma-Pa Da Pa Śa

Av. Śa Ni Pa Ma-Ri Ga Ma Ri Sa

*Mela 39.***Varāli.**

Ar. Sa ri Ri ma Pa da Ni Śa

Av. Śa Ni da Pa ma Ri ri Sa

or Here Ri (ga) is called Suddha gāndhāra in this rāga.

*Mela 53.***Hamsānandi.**

Ar. Sa ri Ga ma Da Ni Śa

Av. Śa Ni Da ma Ga ri Sa

*Mela 59.***Ranjani.**

Ar. Sa Ri ga ma Da Śa

Av. Śa Ni Da ma ga Sa Ri Sa

*Mela 65.***Hamir.**

Ar. Sa Ri Sa Pa ma Pa-Da Ni Śa

Av. Śa Daa Pa Śa Ni Ri Śa-Pa ma Ga Maa Ri Sa

As a matter of statistics I tabulated the number of kritis (and kirtanas) etc. of Thiagaraja in a printed book containing only the words of the melody to ascertain what rāgas the great saint and composer delighted in, as an indication of their aesthetic beauty.

The largest compositions known by the name 'Pañcha Ratnas' or the Five Gems are in Gaula, Nāta, Sri Rāga, Ārabhi, and (Jhala?) Varali. Out of the total of over 650 melodies enumerated, the five rāgas, Sankarābharana Hanumatodi, Sourāshtra, Sāveri and Kalyāni carry the palm, each having over 20 compositions.

Next come the 14 rāgas, Bhairavi, Madhyamvati Ārabhi, Yadukulakāmbodhi, Punnagavarāli, Atāna, Devagāndhari, Kharaharapriya, Ritigaula, Kedāragaula, Begada, Bilahari, Sahāna and Mohana, with ten compositions or over in each. Next in order come the 11 rāgas Kāmbodhi, Harikāmbodhi, Asāveri, Dhanyāsi, Sāranga, Mukhāri, Darbār, Suddhasāveri, Nilāmbari, Āhiri and Surati, with over five compositions in each. So much confusion exists to-day regarding rāgas Subha Pantu Varāli, Varāli *alias* Jhāla Varāli, and Kāma Vardhini *alias* Pantu Varāli, that I have not had them separately listed. Every South Indian with any claim to a decent musical education or knowledge, knows and delights at least, in the rāga Bhāva of these thirty-five or more rāgas.

CHAPTER XIII.

OBSERVATIONS.

Staff notation :—

I should think that every Indian, who is true to the genius of Indian Music will resist the attempt, to write music in staff notation. We have a sufficiently reliable method of writing music correct to the 12 svaras or the 12 rough pitches in the octave, both in relation to time measure and the particular svaras entering the music. The more capable student, when once the rāga bhāva is

known, is able correctly to sing the melody after some effort, understanding the present day notation, which, is just the skeleton framework, and the sense of natural intonation fills in that framework. It may take some years of musical study to understand the rāga *bhāva*, but that is no reason why we should go in for a staff notation, which does *not* carry an *auditory* impression, also at the same time. As I have said, the svaras Sa Ri Ga Ma Pa Da Ni with flats and sharp, when sung and understood, convey both a *visual and an auditory* impression with a texture of spoken words, and it is an evil day when we shall choose to reject this method, which has led to development of melodic music and stood the test for over two thousand years.

Note added in the 2nd Edition.

Mention was already made of Subbarāma Dikshitar, a scion of the great composer, Muthuswāmy Dikshitar. In the year 1904 he published a voluminous book of melodies of his ancestors, covering over two thousand pages, with a view to stabilise the composers' songs in notation. He adopted the European signs of flats, double flats and sharp, to denote the svaras comprising each rāga, at the head of each composition, treating the Sankarābharana svaras, Sa Ri Ga Ma Pa Da Ni (in the Telugu alphabets) as those requiring *no* signs. On the analogy of crushed notes in violin play in Staff Notation, eleven symbols were devised by him to represent the gamakas in the vīna, each symbol being explained in a preface, with reference to simple melodies in well known rāgas. Gamakas are, after all, mechanical movements of deflections of strings across frets; and a highly analytical mind is all that is required to trans-

cribe them. If the system of symbols is taught in the early stages, a code is thus created for the understanding and learning of new pieces by oneself, for an advanced student, once the rāga bhāva is understood. Of course, the micro-tonal variations have to be felt and experienced for the correct rendering of the rāga bhāva, and so they cannot be put in signs.

A similar work, in notation and gamaka signs, with three additional signs considered necessary, has been brought out in 1947-48 by Mrs. S. Vidya, for sixty-two kritis of another contemporary and great composer, Syāma Sastri (pp. 250, 9" x 11"), having learnt them in the traditional form from the great grandson of the composer, for the stabilisation of his melodies. This code should be taught, in my opinion, to vina students by vina teachers and for the comprehension of vocalists.

General Remarks about Violin and Vina Play.

Art-music mostly lies in the vowel sounds. But a question may be asked "How is the correspondence between the vocal music and the music on the instruments produced, and how is the effect of the pronunciation of the words brought into play?" Though this may be stated to be generally by gamakas so far as the intonation and grace are concerned, the consonants appearing in the melody are indicated by a change in the direction of the bow of the violin, and by a fresh plucking of the playing strings on the Vina. This makes it unnecessary in the writing of our music for any signs as to when the direction of the bow changes. The word of the melody, that is the consonant with its vowel ending, will just appear under the corresponding svāra.

A word also about present-day vocal music. I have generally noticed, even among the better class of musicians, that the intonation of the vowel sounds is *not* quite correct. The Sanskrit 'ah' is like 'father' or 'calm' or as राम Rāma, both as long and short; but unfortunately a sound like 'cat' is coming into operation. The latter sound of 'a' in the word 'cat' is not at all observable in any Indian language, and is very strongly deprecated in music. Also in the *svara* singing or *tanams*, it is correct to restrict ourselves to the 'ah' sound in father, as it is the most resonant vowel. Odd examples of 'oh' and 'eh' being used, for instance, in *regular rāga ālāpana* are deprecated. As regards Vīna play, there is a tendency to have more pluckings of the played strings than necessary. The prolongation of vowel sounds must be induced by simple pressure, by the fingers of the left hand across the frets, and fresh plucking would spoil the beauty of gamakas. Yet among the musicians of Mysore and the Andhra province, an enormous amount of plucking of the played strings is noticeable, which is not consonant with the traditions of Tanjore music, especially as regards the musical compositions of Kritis.

As I have already said, it is where the consonant of the word of the melody appears, that the fresh plucking of the vīna string or the change of the direction of the bow ought to take place, and *nowhere* else as far as possible. The stresses and strains of rhythm may be produced by the violin bow in the prolongation of vowel sounds as occasion may require, perhaps more easily than on the vīna itself.

It will not be out of place here if I mention some characteristics which I have observed in regard to *sahitya*

or the words of a good melody. It is needless to comment on the subject matter, *i.e.*, the meaning of the words, as they should convey some lofty ideal or breathe adoration. I should refer only to its purely linguistic phase. That melodic music has the greatest aesthetic value in which the consonants are mostly *soft* consonants, and semi vowels largely occur. Conjunct consonants should be absent as far as possible, and if at all they occur, they should be syllables like 'tma', 'nya', 'dma' 'tya' 'nta' 'mma' 'nna' 'nja' 'sma' 'nda' and such others. And further, each monosyllable must have a vowel ending and the word itself have a vowel ending. The Telugu of South India satisfies these conditions, best to my knowledge, among Indian languages, and this is probably the reason why Tamil composers even chose Telugu as the vehicle of their music in recent years. Sanskrit also is occasionally capable of such phraseology and some of the songs of Jayadeva satisfy the above conditions, and that is why they have not been lost, though their original notation has not been preserved to us.

Another feature of melodic music I should mention. It should take the intonation of common spoken language, and the vowel sounds should not be elongated very much at one pitch; for a single note is certainly no music, and the elongation possible should be the period of time in which the voice can take some rest. Nor should the music be so fast, as the present tendency seems to be, lest the human touch should be lost. Probably stringed instruments and their technique are responsible for such fast music, but this tendency to play very fast melodic music should be curbed. Again, the

vocalist to-day in singing his classical compositions barely understands the meaning of the song and the emotional effect of the song is lost upon us; for I am sorry to say that the high and lofty faith, which inspired the composers, is woefully lacking in the singers, and therefore an effort should be made by them to understand the words of the song.

In recent years, Karnātic music has come in for a lot of criticism by Hindustāni musicians: (1) it is highly intellectual in character. (2) it is highly mechanical. (3) as a matter of mathematical computation, it tries to achieve the aesthetically impossible task of obtaining a large number of rāgas. (4) it does not base its rāga system on the *vadi* and *Samvadi* arrangement, as understood in Hindustāni music.

Against all this criticism, I would just cite only one instance in the history of Karnātic music. The rāga *Karaharapriya*, with the svaras Sa Ri ga Ma Pa Da ni Sa, in both *ārōha* and *avarōha* was not sung, and no compositions in that rāga were available before the time of Thiagaraja. The ancient (Karnātic) *Bhairavi* true, took Da occasionally, but mostly used da in its melodic effort, and it is due to the genius of Thiagaraja that *Karaharapriya* has become largely prevalent in South India. Though I am just a novice in Hindustāni music, I have perceived by comparison, say, of *Sriranjani* of South Indian music with *Bageswari* of Northern India, the svaras being Sa Ri ga Ma Da ni Sa in both cases, the difference in technique is understandable, and the South Indian rāga is richer in its variations of the six selected svaras (as *pañchama* is absent). Similarly,

comparing Ābheri, a rāga of South India, with Bhimpalāsi of Northern India, there is difference in the method of approach, both having Sa ga Ma Pa ni Śa in Āroha and Śa ni Da Pa Ma ga Ri Sa in avaroha. The difference is largely due to the small variations, as I perceive, in the microtonal changes of the svaras in the ascent and descent. Similarly as regards rāgas Bhairavi of Northern India and Thodi of South India, or Bhoop of Northern India and Mohana of South India, or Tilang of Northern India and Nātai of South India, and several others.

The Northern Indian musician may be aware of the 22 śrutis in the octave but he has not attempted to use them in his rāgas to a very large extent in regard to the selected svaras, as I diagnose the case. This feature is seemingly responsible for the feeling of monotony, that the South Indian feels in listening to Hindustāni rāgas.

In fact, I may say that the vocal Hindustāni music, where it has not been vitiated by the advent of the harmonium, has received the impress of the mechanical possibilities of their instrument Sarangi. (This is really an inverted violin played upside down, but against the finger nails themselves. Though it has 24 to 30 *resonating* strings to create the intonation of the human voice, it has only strings tuned to 12 different pitches in the octave creating a buzzing sound. I had almost said these 12 pitches belie the ancient theory of 22 śrutis.) Similarly the vocal music of South India has been following the mechanical possibilities of the vina. Hence the tensions and the pulls in South Indian music, which are more expressive of all types of human intonation.

Speaking of samvādi and vādi, that is, a relation of the true fifth or fourth, pupils of Vishnu Digambar (an eclectic musical mind) have now taken up singing the Simhendramadhyama, observing the South Indian scale (Sa Ri ga ma Pa da Ni Sa). But the Hindustāni will find fault with Shanmukhapriya Sa Ri ga ma Pa da ni Sa, simply because ma and ni have not the relation of the fifth; but we South Indians know the latter as a very decent rāga. The South Indian has not restricted his rāgas to *only one Vadi or Samvadi* note in each, as in northern rāgas.

How pertinent is the quote from John Dewey (1935) at the head of Chapter XI to the evolution of the Karnātic melodic system! It is only after the satisfactory placing of the 12 frets to the octave or of the 24 in the two octaves, of the Vina, dating probably from Ramamatya (1550 A. D.), who styled it as the *sthira* (fixed) Madhyama Mela Vina, that Venkatamakhi formulated the possible 72 melodic scales. Northern Indian stringed instruments, like the Sitar, Esraj and Dilruba, *even to-day*, have *no* pretensions to this achievement. Venkatamakhi (1640 A. D.) mentions only 19 parent scales in use in his days, and Tulaja of Tanjore (1783), mentions just 21. The imaginative guess of 72 scales was explored by the lofty genius of Thiagaraja (1767-1847), who created and composed melodic pieces, with an aesthetic fulfilment in 45 parent scales, taking the seven selected svaras of the scales, besides others in 220 janya rāgas in the several scales with a definite Rāga Bhāva, though their expansion (Vistāra) is difficult, as they are beautiful small pieces with facets of brilliance. (added in 2nd Edition)

Of course, as has been truly said, "Music has its light moments, its charlatans and its academics"; hence South Indian music should not be judged merely by the fact that many exponents in vocal music do not come up to the high standard of true musical sounds, so far as they go, of several reputed Hindustāni musicians who have visited South India, since the curvature and graces are more difficult in the Karnātic art. But the Vīna and the violin are certainly played quite true in South India.

One may certainly say that Karnātic music is highly intellectual and has less appeal to emotion, but this carries no discredit in my opinion. When Shelley has written a "Hymn to Intellectual Beauty", it is quite justifiable that æsthetic beauty can be understood by means of the intellect, and not alone through emotion, just as virtue itself has been taught as an intellectual concept by Socrates, though felt as a pure emotion by Jesus.

A few words about the Mridanga used as an accompaniment to melody both for vocal and instrumental music. The centrally loaded membrane gives out also the partials 2, 3, 4, 5 (alike on the Vīna see p. 17)—*vide* Sir C. V. Raman's Paper on 'The Indian Musical Drums' in the Proceedings of the Indian Academy of Sciences,—Bangalore—Vol. 1, No. 4, Oct. 1934.

CHAPTER XIV.

MUSIC, EMOTION AND AESTHETICS RAGA AND RASA*.

Music is my hobby and so I propose to speak to you to-day on this subject. There is a saying 'One can ride

* Lecture delivered in Bombay on 30-11-'35.

a hobby horse to death'—but I do hope that before the end of my talk I shall be able to communicate to you some of the joy and happiness which I derive from the hobby of music; I can demonstrate on the violin if I am allowed, and affect you too. Musical talent, if I may frighten you with a big word, is a Mathematico-sex complex: but you all know Shakespeare's famous passage in "The Merchant of Venice"—"the man that has no music in him and is not moved by the concord of sweet sound is fit for treason etc., and that no man should trust him." Sure enough, the audience before me is not of the kind Shakespeare referred to.

You are all aware that music moves us, and we do not know why—we feel the tears, but cannot trace their source. It is said of the Greek Orpheus, and of the Hindu Narada that they, by the music of their instruments, the lyre and the vina, "drew trees, stones and floods"; aye, "Music hath charms to soothe the savage beast, to soften rocks, and to bend the knotted oak." The Sanskrit proverb, you know is—"that the cow is drawn by music, the child is lulled by it, the serpent feels it, and the man, who does not feel the power of music is only an animal without a tail".

You may recollect also Shakespeare's opening lines in "The Twelfth Night". 'If music be the food of love, play on.' We also resort to music when we are in the grip of deep grief, when our heart is wounded, and our mind oppressed, for we know music helps to relieve us of our grief and to forget; and we ask ourselves the question "Why should music affect us?"

Nay, by the best Indian melodies, we are led to a glimpse of the Infinite, and to gaze upon it. The highest melodic music of India has always been what we call sacred, tending us to spirituality, when no more of our earthly burdens and trammels are felt, and we are lifted to a higher sphere of consciousness and the feeling of the Divinity within us: I make bold to say that where 'priests have failed in their mission', musician artists like Thiagaraja and Dikshatar have taken their place. It seems to wash away, from our hearts, the dust of every-day life. One may contend that in vocal music, the meaning of the words affects man; but why should music through stringed instruments, reproducing the nuances of the human voice, just like primeval speech, akin to that before man ever learned or spoke any language, affect us? Can we offer any explanation?

The Sanskrit Aesthetic critics have defined, for the dramatic art, nine Rasas (emotions). Two more Rasas have been added later, and I add to these one more "Ananda" or joy. Bhakti Rasa to my mind (devotional spirit) is not a simple emotion.

The emotions are :

- | | |
|--|--------------------------------------|
| 1. Sringāra - Love. | 2. Hāsyā - Laughter. |
| 3. Karuna - Pity. | 4. Çoka - Grief. |
| 5. Raudra - Anger. | 6. Veera - Heroism. |
| 7. Bhayānaka - Fear. | 8. Bhibhathsa - Terrorising
look. |
| 9. Adbhuta - Wonder. | 10. Çanta - Peace. |
| 11. Vātsalya - Tenderness
as towards a child. | 12. Ānanda - Joy. |

Music embraces these ⁹ Rasas and awakens in us these emotions. The melodies of India have certainly been able to induce in us these emotions, though not all to the same extent. Nay, further, Nature's moods, such as the freshness of the dawn, the soft fall and calm of sunset, the moods which carry peace and joy unto the soul, have been embodied in our melodic music.

Addison says "Music is the only sensual gratification, which mankind may indulge to excess without injury to their morals or Religion." I am not so very sure of this dictum. A feeling of love, (sringāra) may be awakened in us by music, and one has to be careful that it does not deteriorate to eroticism; and highly erotic music in excess would injure moral feeling. In fact, music of the lower sort is fire to play with, as we know it of late, in the decrepit Moghul, and other Princes' Courts in India. As for martial music, it is but an instrument of the devil, not at all consistent with the soul of a world humanity.

The recent South Indian melodies of the three great composers, Thiagaraja, Dikshatar and Syama Sastri of the late 18th and the first half of the 19th centuries in the Tamil land, have, more or less, Bhakti, or faith, as their subject-matter. In their hands, the spirit of Contemplation or Peace of Soul is induced—as I have already alluded to, and the calm or peaceful mood is dominant. Indian melodists have all had conceptions of Rāgas from the very beginning of Indian Musical History, and in the present day evolved music of India, and especially of South India, Rāga and its Bhāva are supreme in their concepts. Can we recognize that any particular Rāgas have any definite

emotions, and can they create the feeling of one of the several Rasas referred to ?

As a practical artist, I feel I can associate the emotions arising in me though the power of pure sound in rāga ālāpana, with the particular arrangement of svaras of the ascending and descending notes. For instance, in Nilāmbari, Nādanāmakriya and Mukhāri, one does certainly feel the emotion of grief, and it is as well that the theme of these rāgas be also of profound grief so as to assimilate the sahitya (language) and the emotion. Sringāra (erotic aspect of love) is more represented in the Hindustāni 'khamās' rather than in our own rāga 'khamās' which differs from the former only in respect of an accidental higher Nishāda absent in the latter.

Vātsalya (tenderness as towards a child) is depicted to my mind in Ānanda Bhairavi, Yadukula Kāmbodi, Madhyamāvati, and Srirāga of South India; whether it is so, by the association of lullabies heard in childhood I cannot say. But those impressions last long. In Kalyāni, especially when sung towards evening, I seem to feel the oncoming of the twilight and the shooting up of the stars. And as a hush comes over nature with darkness, there arises a restfulness in my consciousness. In Kambodhi, especially in the Trīśruti Dhaivata, as I elaborate the rāga round about it, I feel a sense of peace pouring into my soul. In the Tholi of South India, there is that vague tenderness, which is not associated with grief or parental feeling.

In Sankarābharana, though in some pieces like *Elāgudayavatsuno*, there is pervasive self-pity combined

with adoration, it should be possible for a composer to create in this rāga, with a stress upon the antara gāndhāra (the higher Gāndhāra which merges with 'Sa and Pa') a sense of 'joy in life', which can pervade the whole rāga. To this feature of 'Ga' I attribute the vivacity of the European song in the Diatonic scale and it should be possible for us to compose songs in this rāga to depict the joy of life and to enable us to find happiness in this world here and now.

In Saveri and in Bhupala (Janya in Māya mālava Gaula) taking Antara gāndhāra, Suddha rishabha and Suddha dhaivata, (in South Indian nomenclature) I feel the freshness of dawn; they are particularly, *physiologically* if I may say so, suitable for the morning hour because the vikruti notes are just above or below the 'Sa, Pa and Ma' in these rāgas. Thus 'Nāda' or sound becomes the object of "Tapas" (austerity or concentration.)

The feeling which every different Rāga induces is difficult to portray, and there has been an aesthetic development of rāgas distinguished from feeling or emotional content. To give a parallel from portraiture, the Japanese who is used to his Mongolian eye has his own conception of the beauty of woman, which may not be pleasing at first sight to an Indo-Aryan. Similarly, the Grecian face and nose are different from that of the Teutonic. So also the aesthetic beauty of different Rāgas has come to stay in the land.

The different tastes in the Indian mind were created firstly by the great idea of Venkatamakhi, who lived in the 17th century in South India, of the classification of Rāgas

into 72 scales, together with their derivative rāgas, in which certain notes are left out in the ascent or the descent in each scale, and secondly by the genius of the nomenclature of the svaras, extant from the days of Panini who lived about the 4th century B.C. as | Sa, Ri, Ga, Ma, Pa, Dha, Ni | the notes Sa and Pa being fixed in relation to the fundamental pitches, and the other five having a variation of sharp and flat, of course roughly speaking, by which means musical phrases themselves, in svara singing, got the texture of words.

It may be noticed that the monosyllabic words Sa Ri Ga Ma Pa Da Ni, that is the svaras, have all vowel endings and have only two such vowel endings, namely ā and ē (अ and ई) and that can be elongated as आ and ई, also to any extent of time measure wanted. One word more about the aesthetic beauty of melody. In spite of all the restrictions, which are placed in respect of the particular svaras, roughly speaking, which may enter into the composition of a melody or rāga type, there is and can be noticed a *fluidity of outline*. Our music is highly and elaborately articulated. One feature, which perhaps pleases an instrumentalist, a player on the Vina and the Violin even more than an vocalist, is the flow of pure vowel sounds, containing only vowels of varying pitch. The totality of effect in linear representation is the feature of Indian rāgas, and this perfect art, with a natural intonation, has an ease delighting both the layman and the expert. Finally, the most aesthetic experience in melodic music I shall now describe. It is called the *sruti gnāna*. It connotes a finer perception than the *svara gnāna*, or the knowledge of deciphering music by the 12 rough pitches

in the octave. It is beyond words to impart that perception, and one can feel it in the play itself. It comes on like a flood, if it comes at all, when maturity is reached; and in it, one feels one's most thrilling experience in melodic music.

CHAPTER XV.

MUSICAL METAPHOR—WHAT THE VIOLIN HAS TAUGHT ME.*

We often compare musical instruments with the human body describing the Sarasvati-Vina as a Daru Vina—'Daru' meaning made of wood and the human voice as a *Gātra* Vina, thereby giving the former a rank just below the human voice in its appeal.

The ancients do not, however, stop here. Imagining the vina inverted, the comparison is pushed further by the analogy of the vertebral column with the finger board of the Vina, the twenty-four frets of the latter being supposed to be similar to the separate pieces of the former. The two apertures on the face of the bigger gourd are said to correspond to the eyes of man, and the 'Yali' or the figure at the end to show the tail of the spinal column. It is here we feel the aptness of Johnson's remark that "comparisons are odious."

Yet, right through the ages, poets have fancied, in different musical instruments, the human characteristics. As a lover of the violin, a Western instrument, which has come into vogue in India for the last century, the ideas

* Originally written for "The Hindu" and reprinted with permission.

which have found expression, either in common talk, or in literature, art and ethics about the music of the violin have interested me.

The violin player is sometimes the subject of derision and ridicule. Of one who has a dismal look, we say he holds his face as long as a fiddle. We exclaim of a poor player, "My Lord, how he scrapes the violin!" Sometimes, we say in anger "fiddlesticks!", referring to any matter as worthless. These gibes at the violin, perhaps measure the despair and disappointment of its ordinary votary, who would seek to impress his audience long before he can get its mastery. Yet high class violin bows cost as much as a hundred rupees, and violins of good tone are worth a fortune.

This superb instrument has taught me to feel for it something akin to love. Shall I call the violin, she or it? With all apologies to the ladies, I shall use the feminine gender. Be rough to her, she yields no music; but coax her and forget your ego, she responds sweetly, as though she had a soul of her own. Honore De Balzac writing on the subject of love observes, "Woman is a delicious instrument of pleasure but it is necessary to know its quivering strings, study the pose of it, its timid keyboard, the changing and capricious fingering." He also says, "Man generally is as ignorant of love as an orang-outang of violin play." To Dryden, the poignancy of its appeal is apparent as to lovers

*"Sharp violins proclaim
Their jealous pangs and desperation
Fury, frantic indignation,
Depths of pain and heights of passion"*

Then there is the pathetic spectacle of the violin player unable to soar to the desired height, described by Gustave Flaubert, writing on literary style :

“I am like a man whose ear is true, but who plays falsely on the violin; his fingers refuse to reproduce precisely those sounds of which he has the inward sense. Then tears come rolling down from the poor scraper's eyes and the bow falls from his hand.”

Further, the pride of the musician, call it what you will, the pride of self-knowledge (*Ātmagnāna*) of the knowledge of God (*Dēvagnāna*) is reflected in Browning's affirmation; “But God has a few of us whom He whispers in the ear; the rest may reason and welcome, it is we musicians know.”

Shelley, the most psychical of poets, gives expression to the same thought, that great music can come only when there is deep feeling within,

*“As music and splendour
Survives not the lamp and the lute.
The heart's echoes render
No song when their spirit is mute.”*

TUNING THE VIOLIN.

The tuning of this instrument, as done in South India, is different from the European style, the latter being by fifths—as *Sa Pa Ri Dha* or really *Pa Ri Dha Ga*. Even the tuning has taught me some valuable lessons in psychology. The psycho-physical parallelism, which regards the human entity as mind-body, has its counterpart in the concord. The ‘Sa’ ‘Pa’ of the lower octave

being in unison with 'Sa', 'Pa', of the higher octave, makes me appreciate and rightly understand the words of Browning :—

Let us not always say

Spite of this flesh to-day

I strove, made head, gained ground by on the whole

*Let us cry 'All good things are ours, nor soul helps
flesh more, now, than flesh helps soul'*

In this unison, the higher octave strings represent the more fleshly desires and passions of man, and the *mandara sthāyi* strings are comparable to the *Manas* and *Buddhi* of man.

To one who has felt the appeal, there is neither convention nor set technique in his art. Once when I was playing before an Indian violinist, an artist in a Military European band, who had not heard previously South Indian music, asked, as he heard my violin tuned, "What have you done to the violin that it is so beautiful?" Then I realised that an Indian is in his heart of hearts only a melodist.

The violin has taught me the right use of leisure. The occupation of man in his leisure moments truly measures his culture. We in these modern days are proud to throw a coin over the counter, take a seat to hear either mechanised music, or other artists, and console ourselves that we have purchased happiness. But the essence of joy is accessible only to those who patiently withdraw themselves during leisure hours, inspired by true love of the art, in the true joy of the practising artist, when they have

attained some level of perfection in the art by their own unremitting effort. It is this peace and knowledge of eternal varieties which our Rishis wanted us to cultivate so that it may permeate our daily lives and make us better fitted for the day to day work of this world—for “where the priest has failed in his mission, the artist musician like Thiagaraja fills that place.”

The violin has also taught me some lessons in ethics. As melody can be played only on its tightened strings, kept in proper tune, it has taught me that in all human life, there is a moral tension, whose adaptation to evoke melody has made me realise the wholeness of life (and the resolving of conflicts), and of ceaseless activity in the world associated with the contemplation of the Divine. Count Keyserling has expressed himself thus :—

“The fulfilment of that life, which is the life of free creative man is related to these problems (of human happiness and sorrow) which seem to contradict the idea of cosmic order ruled by the spirit of goodness and beauty, much in the same way, as the melody is related to the violin.”

EPILOGUE (IN THE FIRST EDITION).

When the major portion of the book was written, I came across a reference to my booklet with the title “A Note on the Śrutis of Karnātic Music” published in 1929. The reference is found in the publication of the Madras University, “Rāgas of Karnātic Music” (1938) by N. S. Ramachandran at p. 47, and reads as under.

“Mr. C. S. Iyer in his valuable pamphlet says that 3 more śrutis should be welcome as additions to the 22

śrutis (this resembles the view of Mr. Clements), and that the South Indian ear is even sensitive to as many as 30 śrutis in all. The latter statement is important because it indicates the truth of the practice, and also because it questions the validity of the 22 śrutis."

At the time of publishing the booklet in 1929, I was naturally drawn by my violin technique to the observation of the slight but definite changes in *pitch*, also felt by the ear, occurring in the 12 svaras, as ordinarily denominated, and *that they are not alike in all rāgas*. This, I checked with the help of a long sonometer, taking great care that the tension of the string does not alter, by putting a wedge underneath, and reading off the lengths of the vibrating portions of the string. It is indeed a *crude* method, as after all, a stretched string is a catenary though fairly tight, and helped by mathematical working, backwards and forwards from Sa Pa and Sa Ma, I arrived at the results of the 22 śrutis, which are also taken to be true by Helmholtz in respect of the Persian and Arabian music. The Māya Mālava Gauḷa rāga, however, in which all first lessons in music are learnt in South India created some difficulties in regard to the frequencies. Then I postulated, as far as my ear could judge, by the sonometer, that the three notes $48/25$, $25/24$ and $25/16$ are essential in our music, and these are the three additional notes which I suggested, ought to exist. The corresponding ratio on Sa string $32/25$, will also enter in Māya Mālava Gauḷa rāga. Then I thought that the small variation of 22 cents ($81/80$) from the *linaka* svaras, where the voice could stand, could perhaps justify the variations in our music, that is to say, the semi-tone dropping to a 90 cents interval,

the major tone dropping to a minor tone, and minor tone becoming a major tone as may be necessary and that these changes should sufficiently explain our South Indian music. But the tests carried out by the tuning forks to a large extent deny the theory of śrutis being pure gamakas to the extent of a comma, from linaka svaras; because, at many of the 22 śrutis, the voice does stand and elongate the svaras as I illustrated in the ratios $7/4$, $7/6$, $7/5$, which do not figure however, in the ratios obtained on Sa Ma and Sa Pa bases.

I am unable, however, to agree with Mr. Ramachandran that the very complex frequency ratios (such as he observes at pages 50 and 206 of his book) can all occur in our music. The method of measuring frequency ratios by the sonometer is too *inaccurate* to say quite positively that they do exist, since certain mathematical laws must prevail in the art of music. As I have already said elsewhere, "To attempt to describe an art is an illusion." I also attempted in 1934 to obtain sound photographs of violin curves from the Teddington Laboratory, London with the help of a Duddell oscillograph (a copy of the report is given just after this chapter). It is just annexed to show any future investigator the method which may be adopted for taking out curves in violin play for the study of śrutis.

NATIONAL PHYSICAL LABORATORY,
TEDDINGTON.

REPORT ON THE OSCILLOGRAPHIC RECORDING OF
CERTAIN VIOLIN NOTES.

PHYSICS DEPARTMENT.

For : Mr. C. Subrahmanya, London.

Object of the work:

The object of the work was to obtain oscillograph records from which the pitch relations of certain notes and phrases, described as occurring in southern Indian music, might be determined.

Method of experiment.

The notes and phrases concerned were played by Mr. Subrahmanya on his violin. The sound from the violin was received by a condenser microphone distant about 2 ft. from the violin, and connected through a valve amplifier to one of the vibrators of a Duddell Oscillograph. The wave from of the sound was recorded on photographic paper by means of a revolving drum camera attached to the oscillograph. A time scale was provided on each record by a second vibrator which registered the wave form of the electrical output from a standard valve maintained tuning fork, operating at a frequency of 1,000 cycles per second. The player and the receiving microphone were situated in a lagged cabinet so as to avoid as far as possible, any interference from extraneous noise. Communication between the player and the operator of the recording apparatus was maintained by a system of visual signals, controlled by the mechanism of the shutter on the recording camera, the player being warned one second in advance of the opening of the shutter and also at the commencement and conclusion of the exposure. The duration of the exposure was approximately one second in each case.

Description of Records:

In all, seventeen records (each 50 centimetres long C.S.) were made.

The description of the phrases provided by Mr. Subrahmanya being, as shown in the table below.

Description of records:

Record No.	Description of phrase.
1.	Open first string (steel).
2.	Surati Ni (First note on record).
3.	Mālava Gaula Ga. (Last note on record).
4.	Madhyamāvatī Ri. (Wavering portion of record).
5.	Begada Da. (Middle note of phrase).
6.	Ānanda Bhairavi ga. (Steady note).
7.	Sāveri Ri.
8.	Sāveri Da. (Wavering note. Middle note of phrase. Phrase probably repeated twice).
9.	Kalyāni Ga. (Wavering note).
10.	Open first string (steel.)
11.	Open first string (steel).
12.	Begada Da. (Repeat of 5).
13.	Sāveri Ri. (Repeat of 7).
14.	Kalyāni Ga. (Repeat of 9).
15.	Thodi Ga.
16.	Thodi Ni.
17.	Open first string (steel.)

The records, numbered and described as in the above Table, are appended to this report. Each record is mounted so that it begins at the left hand end, the upper trace being the time scale and the lower the record of the violin note.

The records were taken in two groups, numbers 1 to 10 and numbers 11 to 17, separated by a short interval of time. The violin was retuned immediately before the second group of records was taken. The first and last record in each group show the wave form of the tone on the open string, thus enabling any variation in the pitch of the string during the experiments to be detected. Three records in the first group, Nos. 5, 7 and 9 were repeated (Nos. 12, 13 and 14) since there was some doubt as to whether the correct portion of the phrase had been played during the exposure. Record No. 7 was defective also on account of some extraneous disturbance which had produced violent distortion in several places on the record. •

(Sd.) G. W. C. KAYE,

Director.

S. 214, 12th February, 1934.

FINALE.

The results of the analysis by a physicist of the violin curves, detailed in the appendix (in this edition) may be summarised as under:

- (i) In da of Sāveri rāga, the variation (or āndolika gamaka in the same svara) is from rel. freq. $25/16$ —a small semitone above Pa—to rel. freq. $8/5$ —a semitone above Pa. On analogy, the gamaka in ri of Sāveri rāga will be from rel. freq. $25/24$ to $16/15$. The variation is 42 cyclic cents.
- (ii) The gamaka or variation in Ri of Madhyamāvatī rāga within the same svara is from rel. freq. $10/9$ —(a minor tone above Sa) to rel. freq. $8/7$ i.e. a measure of 49 cyclic cents, and the comma variation is insufficient.
- (iii) The gamaka in Da of Begada within the same svara is from rel. freq. $5/3$ (a minor tone above Pa)—to rel. freq. $12/7$ i.e. a ratio of $36/35$ subsisting between $9/5$ and $7/4$ or a measure of 49 cyclic cents, and the comma variation is insufficient.

It is interesting to note that the variations in frequencies within the same svara are quarter-tones of definable frequency, which exist between notes arising at certain *aliquot* parts of the Sa and Pa strings. That is, the oscillation in ri and da in Sāveri rāga (page 105) is more than a comma (freq. $81/80$), as the theory of 22 śrutis on

Sa-Pa and Sa-Ma basis would have us believe, and is of the measure of 42 cyclic cents, from one *harmonic* note to another, as defined by me, on the Sa and Pa strings respectively. Similarly, the oscillation in Madhyamāvati Ri (p. 107) and Begada Da (p. 111) are in both cases of a measure of 49 cyclic cents or the quarter tone of freq. $36/35$ and not a comma, as the theory of 22 śrutis on Sa-Pa and Sa-Ma basis would have us believe. They only confirm the truth of the statements made in the first edition (1939) on a preliminary study of musical sounds, by the long sonometer, and later by the standard tuning forks; for instance notice the observation re: Sa Ri, Sa in Sankarābharana at page 80, which has been allowed to stand as in the first edition.

The problem originally faced, in the early stages of 'Hindu' music, in regard to the question of placing the 12 frets in the octave under each of the four strings of the vina and of the frequencies involved therein, must *not* be confused with the actualities of the art music of to-day. Helmholtz, at page 17 of his 'Sensations of Tone' postulated the prolongable notes that could be distinguished; the fundamental being 1, they bear the following relative frequencies: $10/9$, $9/8$, $6/5$, $5/4$, $4/3$, $3/2$, $8/5$, $5/3$, $7/4$, $9/5$, $15/8$, and the octave 2 *i.e.* in all eleven svaras, besides the fundamental and its octave. He also pointed out therein for recognition, the intervals of $81/80$, $25/24$ (the small semi-tone), $21/20$ and $36/35$, all of them lower than a semi-tone of $16/15$, freq. existing between some of them. We have also seen in Chapter I, page 28, how the comma ratio of $81/80$, brings about the *irreconciliability* of the frets on Sa and Pa strings of the vina.

My own study of Karnātic melodic music, has revealed the notes of :

- (i) R.F. $16/15$ — ri_2 having the same position on Sa string that $8/5$ — da_2 has on Pa string, generally short or reached by gamaka.
- (ii) R.F. $7/6$ (septimal minor third) prolongable and having the same position on Sa string, that $7/4$ (septimal minor seventh) has on Pa string.
- (iii) R.F. $7/5$ —where the septimal (7th) partial could be heard on the violin on the silver string, by a light touch.
- (iv) R.F. $25/24$ —above Sa, lower in frequency than the $16/15$, ri_2 .
- (v) R.F. $25/16$, occupying the same position on Pa string that $25/24$ has on Sa string.

All these frequencies can be stated *definitely* to be in use in our melodies, in addition to those mentioned by Helmholtz, *see supra*.

A reference to the several harmonic series, at page 78 from $10/1$ to $10/9$; $9/1$ to $9/8$; $8/1$ to $8/7$; $7/1$ to $7/6$, would show at once the omission of the frequencies $10/7$, $9/7$, $8/7$, $7/6$, and $7/5$ among those noticed already by Helmholtz, though they are mentioned elsewhere. The problem whether they should not be present in the highly evolved melodic Karnātic music, if so where, aroused my interest and curiosity. The realisation that the frequencies $32/27$ and $16/9$ are *not* prolongable svaras, *consonant* with Shadja or Pañchama, gave me the scent to locate these omitted ratios, if at all they exist in

our music. Hence my imagination set to study the āndolika gamaka viz. in Begada Da (5/3) and Madhyamā-vati Ri (10/9) and the results of the enquiry by Duddell oscillograph have indeed proved the truth of the existence of the frequencies 8/7 on Sa string and 12/7 the corresponding frequency on Pa string. Mention has already been made of the upper partials of Shadja (Sa) at page 38. The upper partials (harmonics) of Pa (one of the strings of the drone, a necessary accompaniment to melody) have the following frequencies against the basic 1 of Sa i.e. in the middle octave.

3/2,	9/8,	15/8,	21/16,	27/16	and 33/32
1st	3rd	5th	7th	9th	11th

respectively.

My experience for over 33 years, since the year 1918, of violin play of Tyagaraja's kritis to a vocalist's, or a Violinist's accompaniment, has led me to the following conclusions:

- (1) the interval of the semi-tone (R.F. 16/15) is the most difficult for the human voice to manipulate, for example, in the music with the notation of Ga Ma Pa,—of Sankarābarana, if one would voice it, the Ga becomes Ma Ga with just a crushed note Ma to start with, the duration of Ma being very small and undefined, and the Ga rises in pitch above R.F. 5/4. Or take Ga, Ma Pa—then Ga is R. F. 5/4 and Ma becomes Pa Ma with the crushed note of Pa (3/2) in advance of Ma and there is probably a slight rise in Ma also. The other instances of going up *firstly* by a harmonic

minor third from a prolongable *svara*, before reaching the next *svara*, in Bhairavi and in Harikāmbodī, have been given at page 72 *e.g.*

Ri_1 (Ma) ga Ma | Da_1 (Śa) ni śa | ;
 so also of a *major* third in Māyāmālavagaula

| ri₂ (Ma) Ga Ma₁ | and da₂ (Ša) Ni Ša |
and in Thodi

$\begin{array}{c} \text{(Ma)} \\ | \text{ri}_2 \end{array}$
 $\begin{array}{c} \text{(Śa)} \\ \text{ga Ma} \end{array}$
 $| \text{and}$
 $\begin{array}{c} \text{(Śa)} \\ \text{da}_2 \end{array}$
 $\begin{array}{c} \text{(Śa)} \\ \text{ni Śa} \end{array}$
 $|$ respectively may be repeated here. The svaras in brackets are just touched upon earlier.

- (2) The intervals of a small semi-tone ($25/24$) and of the septimal semi-tone ($21/20$) from prolongable (linaka) notes would *generally* be felt as the next svara among the twelve svaras of the octave.
- (3) The experiments show the clear possibility of an inversion of a septimal minor third ($7/6$ R.F.) from Sa, Ma_1 and Pa in South Indian music. The European has so far recognised only the inversion of a major third ($5/4$) and a harmonic minor third ($6/5$) from Sa, Ma_1 and Pa.

$$4/3 : 7/6 = 8/7; 2 : 7/6 = 12/7; 3/2 : 7/6 = 9/7.$$

Problems for future investigation:

1. The plausible cases of a septimal third inversion may be noticed as under :

(a) in the phrase | Śa^(Śa) Da, Pa | in Sankar-
ābharana

(b) | ^(Śa) Da, Śa | in the words of melody 'Sri Sub'—
of Sri Subrahmanyaya Namaste in Kāmbodi.

(c) The cases (1) of | ^(Ma) ga Ma Pa | in Aṭāna;

(2) | ^(Śa) Da, Ni Śa | in Vasanta, where Pa is
absent

(3) | ^(Pa) Ga Pa in | Hamsadhwani already
referred to at page 50. All require further
study by photos of violin curves; in
Mohana | Sa Ri Ga Pa | to start with would
be 1, 10/9, 10/8, 3/2 while in Hamsadhwani
they would *probably* be 1, 9/8, 9/7 and 3/2.

2. The cases of Ri (varying in several rāgas) are
worth investigation :

(a) [\]Ri [\]Ri [\]Ri, corresponding with letters Te—li—Si
in Telisi Rāma Chintanato in Thiagaraja's Kriti in Pūrna-
chandrika, where Ri comes from above, thrice. Where
does Ri start from and where does it end, since no 'ga' is
heard at all ?

(b) Also in Sa Ri, Sa in 'Sāma' rāga, which seems
different in the oscillating Ri, from the Ri of Madhyamāvatī
Sa Ri, Sa.

3. (a) The case of Ga in Kālyani where it oscillates
without Ma₁ being heard, and if it may *not* be at the
extreme limit 21/16, (7th partial of Pa) which is just below
Ma, since Pa and Ri₂ are important svaras in this rāga,
vide p. 83.

(b) The similar case of ni in Thodi, *vide* phrases in the Kriti 'Tappi Bratiki' (Bro—o—Ova) corresponding to ni, da, da pa Ma; and in the words of 'tsākela' in the Charana of 'Enduku Daya radu' with notation/ni, da, pa/where the ni's have an āndolika gamaka without touching Śa.

4. The cases of the partial $11/8$ just above R.F. $4/3$ and $13/8$ just above R.F. $8/5$ of Sa of the drone and of $33/32$ (the 11th partial) and $39/32$ (the 13th partial) of Pa of the drone have also to be investigated.

The few instances which have been investigated by the physicist may *not* be dubbed off as 'one swallow does not make a summer.' The necessity of several photos by the Duddell Oscillograph of the same gamaka is admitted and the results should be studied. It is my honest opinion that the Duddell Oscillograph plates should be taken from violin play with a *four finger* technique on the strings. On the vina however, the frets may be worn out and the pulls are from different frets, whereas on the violin the first position where the music starts should have to be placed properly and this makes all the difference for an accurate study. It is of course necessary that while the violinist plays there should be judges, vocalists and vina players, also to note whether the music has been played correctly during the second or two of the time when the photograph is being taken. I can however assure the reader that I have even played recently the gamakas set forth in the plates before an experienced audience who confirm that I play true. So much so, I have no qualms of conscience in accepting the results of the physicist's study as correct and reporting the truth of the śrutis.

There is also a new feature, likely to arise in the near future, in violin play if the violin tone is *not* to be killed out by the South Indian artists, namely the *impressionist character* in the production of musical sounds in gamakas. The linear representation, (running the whole length, as in the more ancient painting) of sound as on the vina string, is being replaced on the violin, by the initial and the final position of the gamakas being true, the passage of the violin bow giving the ear the *illusion* of continuity, which does indeed suffice for the melodic art.

The glory of Thyagaraja's melodies lies to my mind in the fact that he always aims at harmonic intervals of R.F.s. $7/6$, $6/5$, $5/4$, besides $4/3$, $3/2$ which ancient theorists held, from prolongable svaras, and the maintenance of a harmonic series from Sa and Pa of the drone brought down to the middle octave, (besides their upper partials) in the svaras of his melodies. This feature seems to differentiate him from his other contemporaries Dikshitar and Shyama Sastri. In the 'artistry' of Syama Sastri, however, several such instances can also be noticed.

That the so-called '*Vivadi Dosha*' rāgas, wherein certain adjacent svaras have *roughly* the semi-tone interval, with ranges larger than a major tone regarding others, have been exploited by the lofty genius of Thyagaraja, shows that he has realised the passage from one harmonic note to another in a harmonic series, rather than the Sa-Pa and Sa-Ma bases only, (Vadi, Samvadi relationship) of *selected* svaras. These are matters within my experience of musical sounds, and are worth investigation by methods of modern science.

27th May 1951.

C. S. AYYAR.

APPENDIX

Record No. 1. Open first (Panchama higher C. S.)
 String (Steel).

Distance from the beginning in cms.	Frequency in vibrations per second.	REMARKS.
2.0	613	The frequency has been measured throughout the record. The frequency given is the average frequency during an interval of 2.5 cms. and it is tabulated as the frequency at the mid-point of the interval.
4.5	613	
7.0	612	
9.5	614	
12.0	612	
14.5	614	<i>Observation by C. S. :</i>
17.0	609	The Panchama has varied from 608 to 615 vibrations per second. For the study of the subsequent records, except where otherwise stated, the Panchama will be taken at 612 vibrations per second, <i>i.e.</i> , the shadja or 'Saranai' string will be taken as 408 vibrations per second ($\frac{2}{3}$ rds of the frequency of Pa).
19.5	608	
22.0	611	
24.5	608	
27.0	613	
29.5	612	
32.0	608	
34.5	610	
37.0	612	
39.5	615	
42.0	615	The play for the phrases has been only on the E 1st steel string (Panchama) and on the 2nd Gut shadja string.
44.5	615	
Mean	<u>611.9</u>	

Record No. 4. Madhya-
 mavati Ri.

(Wavering portion of record).

Distance from the beginning.	Frequency in vibrations per second.
0	100
1	100
2	100
3	100
4	100
5	100
6	100
7	100
8	100
9	100
10	100
11	100
12	100
13	100
14	100
15	100
16	100
17	100
18	100
19	100
20	100
21	100
22	100
23	100
24	100
25	100
26	100
27	100
28	100
29	100
30	100
31	100
32	100
33	100
34	100
35	100
36	100
37	100
38	100
39	100
40	100
41	100
42	100
43	100
44	100
45	100
46	100
47	100
48	100
49	100
50	100
51	100
52	100
53	100
54	100
55	100
56	100
57	100
58	100
59	100
60	100
61	100
62	100
63	100
64	100
65	100
66	100
67	100
68	100
69	100
70	100
71	100
72	100
73	100
74	100
75	100
76	100
77	100
78	100
79	100
80	100
81	100
82	100
83	100
84	100
85	100
86	100
87	100
88	100
89	100
90	100
91	100
92	100
93	100
94	100
95	100
96	100
97	100
98	100
99	100
100	100

REMARKS

2.5 464

(1)

5.0 463

7.5 468*

10.0 468

12.5 462

15.0 462

17.5 457†

20.0 462

22.5 462

23.8 462

(2)

24.3 460

24.9 468*

25.4 466*

26.0 466*

26.5 467

27.1 466

27.6 467

28.2 465

30.0 458

(3)

32.5 460

33-3 458

34.3 458

34-8 456

35.7 4561

36.5 460

37.5 460

40.0 461

42.5 460

45.0 461

Record No. 4

Observation by C. S.

	Sa = 408 vib. per second.
Minor tone above Sa	Ri ₁ = 10/9 = 433 vib. per second.
Major tone above Sa	Ri ₂ = 9/8 = 459 ,,
Relative Frequency	8/7 = 466 ,,

(1) It is apparent even at commencement when Madhyamavati Ri was being played in gamaka, the photo commenced at a stage, when the R.F. 10/9 had been passed and it had reached R.F. 8/7 from 7.5 to 10 cms.

(2) The photo shows that the note was nearer R.F. 9/8 (Ri₂); the note was again at R.F. 8/7 from 24.9 cm. to 27.6.

(3) The note was going down in pitch, getting to a R.F. between 10/9 and 9/8.

General.—The interval between R.F. 8/7 and 10/9 is 36/35, one of the quarter tones recognised by Helmholtz. Apparently the comma variation of 81/80 is *not* sufficient for the 'āndolika gamaka' *within the same swara* and the variation bears the value 36/35 (R.F.).

'Āndola' is the name given for a gamaka meaning 'Swing between swaras'. Āndolika is a term I have used, for a swing in the same swara.

Record No. 5. Begada Da, middle note of phrase,
played on Pa string.

Distance in cms. from the beginning.	Frequency in vibrations per second.	
2.0	607	(1)
3.0	607	
3.8	674*	
4.7	695†	
<hr/>		
5.5	679	(2)
6.3	680	
7.1	679	
7.9	681	
8.8	675*	
9.6	671	
10.4	672	
12.4	667	
<hr/>		
13.4	675*	(3)
14.0	678	
14.8	679	
15.5	700†	
18.0	691†	
20.5	661	
<hr/>		
23.0	610	(4)
25.5	609	
28.0	608	
30.5	609	
<hr/>		
31.5	(1214)	(5)
32.5	(1214)	
33.4	(1214)	
34.3	(1214)	
35.2	(1214)	
<hr/>		
38.0	609	
40.5	611	
43.0	605	

Record No. 5.—Observation by C. S.

The phrase which was played then was Pa Daa Pa. There is one peculiarity that the steel string has been vibrating at 607 vibrations per second when the finger was not touching it, since the octave of 607 (1214) has also been reproduced in the curve from 31.5 to 35.2 cms. at the 5th stage. For the study of this plate Panchama should be taken at 607 vibrations per second.

R.F. $3/2$ Pa = 607 vib. per second.

R.F. $5/3$ Da = 674.4 „

R.F. $12/7$ = 693.7 „

(1) Even from 2 cms. to 4.7 cms. the change from Panchama (R.F. $3/2$) to Da ($5/3$ R.F.) and thence to R.F. ratio ($12/7$) is noticeable.

(2) The note was fairly steady at a little above Da (R. F. $5/3$).

(3) The note reached again the R.F. ratio of $12/7$ or a little above it at 15.5 cms.

(4) Finally the note in the phrase has dropped to Pa open steel.

General.—The ratio of $12/7$ to R.F. $5/3$ = $36/35$ one of the quarter tones recognised by Helmholtz (equal to 49 cyclic cents). The 'āndolika gamaka' in Da i.e., in the same swara is to the extent of R.F. $36/35$ from $5/3$ the starting note; and it appears a 'comma', variation of $81/80$ does not suffice therefor.

Record No. 8. Saveri da, middle note of phrase,
(wavering note) played on the Pa string.
(Phrase probably repeated twice).

Distance from the beginning in cms.	Frequency in vibrations per second.	REMARKS.
1.5	661	(1)
4.0	653†	
6.5	603	(2)
8.0	607	
11.5	606	
14.0	607	
16.5	609	
19.5	612	
21.5	609	
22.8	635*	(3)
23.1	629	
23.4	627	
23.7	625	
24.0	625	
24.3	631	
24.0	633*	
26.5	633	
29.0	612	(4)
31.5	611	
34.0	637*	
36.5	612	(5)
39.0	606	
41.5	607	
44.0	606	

A detailed study was made
at intervals of 3 mms. to note
whether the frequency 630 was
constant.

Record No. 8.—Observation by C. S.

Pa R.F. $3/2 = 612$ vib. per second.

da „ $8/5 = 653$ „

A small semi-
tone from Pa da „ $25/16 = 637.5$ „

The phrase played, as now seen, is daa/pa/da/pa da/pa,
as noted in the steps above.

(1) The photo apparently commences when the note
da was at $8/5$ R.F. at 4.0 cms.

(2) In the second step, Pa the open string ($3/2$ R.F.)
was photographed.

(3) In the 3rd step the note was oscillating up to
 $25/16$ R.F. even though it was slightly lower from 22.8
to 26.5 cms.

(4) The open string was reached and the note moved
up by fingering to da $25/16$ R.F.

(5) The open string was being played at this step.

General.—Thus the oscillation in da or āndolika
gamaka in da is from $25/16$ R.F. to $8/5$ R.F. or 42 cyclic
cents, a ‘comma’, variation of $81/80$ being insufficient.

Record No. 10. Open first string (steel).

Distance in cms. from the beginning.	Frequency in vibrations per second.	REMARKS
6.5	610	Measurements as in record 1, the frequency tabulated re- presenting an average over intervals 2.5 cms.
9.0	610	
11.5	610	
14.0	612*	
16.5	609	Observation by C. S. :
19.0	612*	
21.5	611	
24.0	609	
26.5	609	The Panchama has been evaluated only at 609 to 612 vibrations per second <i>i.e.</i> it had <i>not</i> changed in its pitch, since the commencement of record- ing.
29.0	610	
31.5	610	
34.0	612*	
36.5	611	
39.0	611	

Extract from the Director's report :

"The records were taken in two groups Nos. 1 to 10 and Nos. 11 to 17 separated by a short interval of time. The violin was retuned immediately before the second group of records was taken. The first and the last record of each group show the wave form of the tone on the open string, thus enabling any variations in the pitch of the string during the experiments to be detected."

The vibration curves were analysed for me at the Indian Association for the Cultivation of Science, 210, Bow Bazaar Street, Calcutta.

C. S. AYYAR.

Butcher knife

RECORD NO. 3.

Open first string (steel).

Date:- 15th February 1934.

Ref:- S.214.

National Physical Laboratory,
Physics Department.

17

RECORD NO. 5.

Madraswalli St.

(covering portion of record)

Date:- 15th February 1934.

Ref:- S.214.

National Physical Laboratory,
Physics Department.

17

RECORD NO. 6.

Sagada St.

(middle part of piece)

Date:- 15th February 1934.

Ref:- S.214.

National Physical Laboratory,
Physics Department.

17



